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REPORTS ON PRIMARY BATTERIES.

PROFESSOR OLIVER LODGE has, as our readers are aware, given a very favourable report on the Upward primary battery, which was fully described by us a few weeks since. It will be remembered that Professor Lodge took great trouble and expended much time over this battery, and that his conclusions are based upon his matured consideration.

The author of this report is not a man likely to be led away by enthusiasm for a new departure in the construction of such apparatus, and his knowledge of the subject is such that very few electricians would have the courage to question his opinions. Yet Mr. Sidney F. Walker has expressed surprise that Professor Oliver Lodge has substantiated the claims of Mr. Upward. Anyone who had recently perused our correspondence columns would naturally suppose that Mr. Walker was a thorough adept in the minutiæ of primary batteries, and it was to show how far this supposition was justified that we challenged him to allow us to publish his voluminous report on the Maquay battery. Our challenge has been accepted—the report may be seen in our other pages—and we will now proceed to make a few comments thereon, which we believe will have the approval of our readers. Mr. Walker expressly stated in his letter to us last week that his report was written for the information of capitalists who were thinking of taking up the invention, and gentlemen of this class are not generally blessed with a superabundance of technical knowledge. In their operations therefore they must necessarily rely mainly upon the opinions of professional advisers.

It will be noticed that the inventor did not feel himself at liberty to disclose certain important features in the construction of his apparatus, the old and well-worn excuse of not having secured protection being given for this reticence on his part. To measure the current of a small battery connected to a 5 candle-power lamp, and the E.M.F. of another *stated* to contain triple the number of cells that composed the first and from this data to base an opinion, appears to us to show a verdant simplicity which it is perfectly delightful to contemplate. The idea of a professional expert being dependent upon the inventor "for information on several points which, however, can be very readily verified later on if desired," naturally makes his report of exemplary value, and the fact that Mr. Walker was able to write an important letter by the light of the lamp attached to the battery indicates a new departure in battery testing.

Notwithstanding the favourable impression the battery had already made upon the experimenter he thinks that by attention to a few of the details, &c., &c., the amount of electrical energy could be considerably increased. He admits candidly that he did not see the larger battery, but that he understood from Mr. Maquay, &c., &c.; yet he is of opinion that many improvements may be made in an apparatus which was invisible to him.

The climax is reached when we are told that "it might very well happen that a battery would do all that has been described as having been done by Mr. Maquay's battery and yet be commercially valueless on account of the trouble and expense of renewing the plates and liquids." "On these points we are at present dependent on the information furnished by Mr. Maquay."

Here is a man who calls himself a consulting electrician admitting that other batteries, not necessarily patented be it known, can do all that Maquay's will accomplish, and then coolly informing the capitalists for whom this report was written that he is dependent for that information, which he is presumably employed to arrive at by actual tests, upon the inventor himself. Then "assuming these facts to be correct" he gives us the astounding information that by using heavier plates, the duration of the battery may be increased. Further, Mr. Walker thinks it most likely that the success which Mr. Maquay has obtained is due to some small point which has been overlooked by other inventors, and that this point should be claimed so fully as to preclude all avoidance of the patent by the rival inventors who will rush into the field as soon as the matter is disclosed. What is this point? Cannot Mr. Walker disclose the secret?

Seriously speaking, this report, which in the interests of electricians and the public generally we have thought fit to publish, contains a tissue of the most meaningless conjectures which have ever come under our notice. Practical details of the apparatus itself may be seen in the present issue of the REVIEW and from the *pot-pourri* our readers can draw their own conclusions.

THE CUTTRISS SIPHON VIBRATOR FOR OCEAN TELEGRAPH CABLES.

THE use of static electricity to vibrate the siphon, with the object of preventing friction at the marking point of Sir William Thomson's siphon record, says the *Electrical World*, has always been the one defect in this otherwise most perfect and beautiful instrument; for, as is well-known, in damp weather, static electricity is difficult to produce and well nigh impossible to control. In such weather the operator working an electrified ink recorder must generally be confined in a room with all windows and doors closed, and frequently lamps or some other sources of artificial heat are placed around the instrument to keep it dry, in order to prevent the escape of electricity. It is necessary to take this precaution, even in the hot and sultry weather of August. The paper on which the record is to be traced must also be kept in various places from cellar to garret, and oftentimes other means are resorted to so that it may be of different grades of moisture; for if the paper be too dry the electrified siphon oscillates wildly across it in its endeavour to discharge itself, while if it be too damp the siphon is discharged too effectually and the record fails.

The present invention, recently patented, obviates all

this trouble by the use of magnetism, and the instrument works just as perfectly be the weather damp or dry. By reference to the accompanying illustration it will be observed that the siphon, M, is slightly thicker toward the point; this is caused by a small particle of iron wire, No. 30 or 32, about $\frac{1}{16}$ or $\frac{3}{32}$ of an inch in length, fastened to it by a little shellac varnish. The magnetic recording table, B, opposite the point of the siphon, over which the paper slip passes, is made partly of iron, and to the back of it is attached the electro-magnet, C. The addition of this magnetic table is all the alteration necessary to any recorder in order to enable the present system to be used.

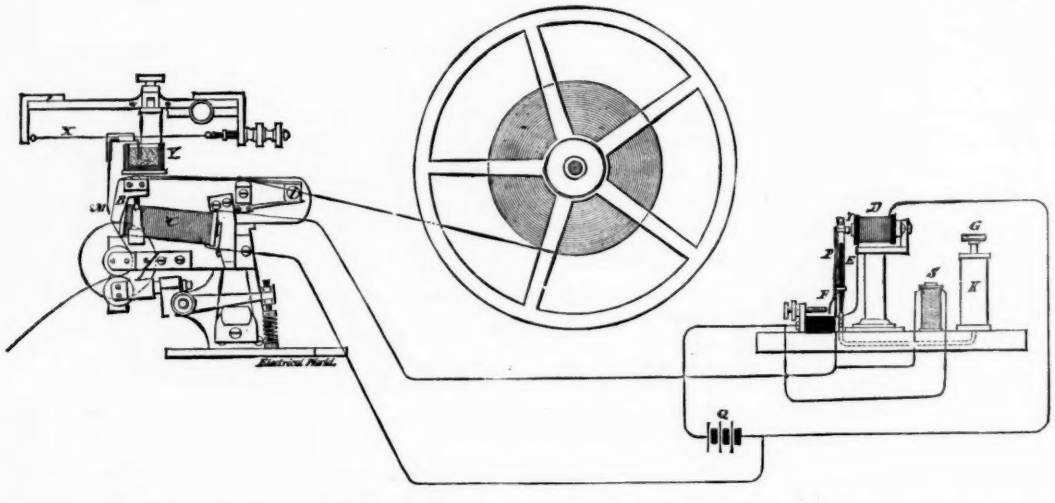
The principal part of the invention is the adjustable vibrator at the right of the illustration. The glass tube, E, and armature, I, which are supported by the steel rod, P, are vibrated by an electro-magnet, D. Continuous vibration is maintained by means of the battery, Q, and the contact points, F. The upright mercury reservoir, K, has a regulating screw, G, the lower end of which is made to act as a plunger; a small India-rubber tube connects the mercury reservoir with the glass tube, E, so that by raising or depressing the plunger the mercury can be forced and maintained at any required height in the glass tube, and by this means its rate of vibration can be changed as may be required. Whenever a new siphon is attached to the instrument it may become necessary to alter the rate of the vibration owing to the fact that even so delicate a tube as one of these siphons (which is about ·01 of an inch in outside diameter), has its own natural rate of vibration, depending upon its weight, thickness, and the amount of strain upon the wire supporting it; therefore, the impulses it receives from the magnetic table must be synchronous with its natural rate of vibration, otherwise the record will fail. When a siphon is attached to the strained wire, X, and it has become filled with ink from the ink reservoir, Y, the plunger is manipulated until the siphon attains its maximum arc of vibration. A perfectly steady dotted line is then obtained and will continue without any other regulation so long as it remains filled with ink.

Generally a permanent steel magnet is arranged so that one pole is opposite the magnetic table, and at about a distance of half an inch from the siphon. This concentrates the lines of magnetic force in such a way that all the battery required is three gravity cells of low resistance. The contact points, F, have a spark-arresting coil, S, connected to them, so that in practice they have given no trouble, and during the two months that the instrument has been in use on the Commercial Cable Company's recorders in New York not a single failure has occurred in their action.

It was feared that the siphon might show a tendency to be attracted laterally toward the centre of the magnetic table, but such is not found to be the case. No lateral movement can be detected, whatever be the position of the siphon when the battery circuit is broken and the table demagnetised; nor is there the slightest retardation experienced to its lateral movements across the magnetic field. In fact, the success of the invention is so pronounced that the company is about to adopt it on all its cables as soon as instruments can be made. There is a wide field for the introduction of this system, as it can be applied to any delicate mechanism of whose movements it is desirable to take a permanent record.

EXPERIMENTS WITH ALTERNATING CURRENT TRANSFORMERS IN MILAN.

AN experiment on a large scale has lately been undertaken by the Edison Company, of Milan, to light the theatre known as Dal Verme. This theatre is at a distance of about three-quarters of a mile from the central generating station of the company in Via Radegonda, and lies, therefore, outside the Edison service of direct supply at constant pressure. The installation at the Teatro Dal Verme comprised 460 Edison lamps, and three transformers of the Zipernowski-Deri-Blathy system, the current being supplied by a self-exciting alternate current dynamo of the type also known as



the Zipernowski pattern. The result of the trial was a complete success, and the Edison Company in Milan has, *Industries* states, decided to put up, before the coming winter, a permanent installation, consisting of three dynamos and over a thousand lamps for lighting the Teatro Dal Verme and the neighbouring private houses. For this service 150 H.P. will be required. The dynamos might be described as of the Lontin type, but there are many improvements in detail, not the least of which is that they are self-exciting and self-regulating. The field-magnets are grouped, star fashion, round a central casting. There are 20 magnets, each about 10 inches long by 11 inches wide and 5 inches thick. At their outer extremity, they are provided with pole pieces, so as to hold on their exciting coils, and present a greater surface of induction to the armature coils which surround, them and are fixed on the inside of a cylindrical casting. The diameter of the field-magnets, which form the revolving part, the armature being fixed, measured over the pole pieces, is 4 feet 10 inches. The armature coils are also wound over coils of the same dimension as the magnets, and there are 20 of these coils employed. These are connected up five in series and four parallel. A branch connection is also taken from two of these coils in order to provide the current necessary for exciting the rotating field-magnets. These two coils are placed at an angular distance of 45°, and are, therefore, at all times in equal phases of induction. The

currents collected from these coils are, of course, alternating like the rest; but before being sent through the field-magnets they are passed through a commutator, by which they are made to flow in the same direction. They are also passed through a regulating apparatus (to be presently described), and thus the strength of the field is regulated in accordance with the external demand for current. The dynamo runs at 250 revolutions and gives 5,000 alternations per minute. The regulating apparatus consists of a small transformer, the primary coil of which is traversed by the whole or a proportionate part of the main current, whilst the secondary coil is, as before mentioned, inserted into the exciting circuit. Thus, if the main current increases, the exciting current induced in the two armature coils before mentioned becomes reinforced by the inductive action of the regulating transformer, and thus the field of the dynamo is strengthened when more current is required. The opposite takes place when, through the extinction of lamps on the external circuit, the demand for current becomes less. Each of the armature coils is designed to carry a current of 8 or 9 ampères, and the three transformers at the theatre are grouped in parallel arc. In the experiments which have just taken place, the main current varied from 1 ampère to 35; but no variation in the pressure could be detected, and the lamps burned with equal brightness, whatever the number in use at any time. This was one of the advantages which determined the Edison Company to make a permanent installation.

The experiment has distinctly proved that the distribution by means of transformers can be carried over a long distance with the same ease and the same certainty as is now possible in the ordinary Edison tube system for short distances with a continuous current. In the experiments of the Teatro Dal Verme, each transformer worked its own independent circuit of lamps, which was the best arrangement to be adopted in a tentative installation. But, if the conditions of the different circuits are alike, they could be coupled up together in any manner desired, and thus a group of transformers could be made a veritable centre of distribution. The transformers which were used at the trial can be arranged to give either 96 or 48 volts, according to the way the secondary coils are coupled up, and this electromotive force is maintained constant at all currents. The dynamo can give a current of 55 ampères at 1,350 volts internal electromotive force. At the trials, the external electromotive force between the main leads was 1,200 volts, and the current was 22 ampères, with all the 416 incandescent lamps alight; it reached 35 ampères when, in addition to the incandescent lamps, a number of arc lamps were fed from the transformers.

In usual work the transformers fed 320 8-candle lamps and 140 16-candle lamps, representing an energy of 16,500 watts, which is about equal to 300 normal 16-candle lamps. The electric energy of the dynamo was about 26,400 watts, of which 6,776 watts were absorbed in the main leads, joining the dynamo to the transformers. The net electrical efficiency, therefore, was 80 per cent. The main conductor was made by Messrs. Siemens and Halske, of Berlin, in a way to avoid self-induction. The out-and-home leads are placed in the same cable, and concentric with each other. The inner cable has an area of 28 square millimetres, and is surrounded by a strong insulating sheath, over which are placed the wires forming the outer cable in a manner similar to that adopted in submarine cables for the protection of the insulating material. The whole is surrounded by a second strong insulating sheath, and the total weight of this twin cable is about $7\frac{1}{4}$ lbs. per yard run. The total of the resistance of the cable, as laid down, is 1·54 ohms.

There are in the generating station various instruments by which it is possible to ascertain at all times the pressure between the terminals of the transformers outside. One of these is a very ingenious contrivance, by which a group of incandescent lamps is fed from the differential current, which is produced by the action of two primary coils and one secondary coil. One of the primary coils is connected to the home terminals of the main line. The other is in series with the main current, and the arrangement is so balanced that the slightest rise or fall of pressure at the terminals of the second coil of the transformers outside is at once seen in a brightening or dulling of the pilot lamps in the station. Apart from this, there is also an instrument which is practically an adaptation of the Edison well-known contrivance for signalling a rise of electromotive force by lighting a red lamp, and a fall of electromotive force by lighting a green lamp, automatically.

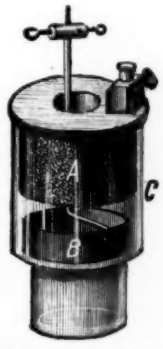
POLLAK'S REGENERATIVE ELEMENT.

THIS new galvanic element (constructed by G. Wehr, Telegraph Constructor, Berlin, S.W.), which will probably meet with extensive application in telegraphy, is distinguished by its simple structure; it requires no superintendence, and it has the further advantage that the materials employed are exceedingly cheap.

In principle it is distinguished from all known elements chiefly by the circumstance that in place of the ordinary more or less costly depolarising agents, it makes use chiefly of the atmospheric air, with its inexhaustible supply of oxygen, for getting rid of the hydrogen.

The element consists of a glass, C, having on its bottom a cylinder of zinc, B, 30 millimetres in height and 75 millimetres in diameter, forming one electrode. The other electrode consists in general of a cylinder of carbon, A, of 80 millimetres in height and 95 in diameter which, from its peculiar construction, combines great porosity with peculiar conductivity, and upon the lower end of which, metal, generally copper, has been deposited electrolytically. After these two electrodes have been placed in the glass, sal-ammoniac or common salt is thrown in, and the element is filled up with water, which must stand 3—4 centimetres above the lower end of the carbon.

FOR CURRENT AT REST.



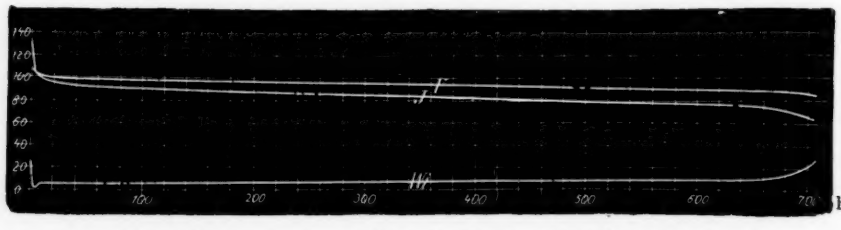
FOR INTERRUPTED SERVICE.

Let us now consider the internal action in the element, when put together. There arise in the first place local currents between the copper deposited upon the carbon and the carbon itself. These currents decompose the salt employed and form compounds of copper. If sal-ammoniac is used there is formed chloride of copper, which gives the liquid nearest the copper a blue colour. When the element is charged a current may be obtained in the outer circuit by connecting the two poles. The nascent hydrogen which is deposited upon the copper reduces these copper compounds, which are formed anew by the action of the carbon, *i.e.*, the element charges itself continually, or, in other words, regenerates itself. Such an element has all the properties of an element provided with readily decomposable depolarising agents, and possesses, consequently, the main property, *constancy*. In this element the gravitation of the liquid plays an important part, hence it must stand quietly. As the upper strata of

the liquid are never saturated solutions, the troublesome phenomenon of crystallising out does not occur.

This element was tested in the electrotechnical laboratory of the Berlin Polytechnicum, and it was closed with an external resistance of 10 ohms. The electromotive force, E, and the difference of tension, E^1, at the clamps of the external resistance were measured with a Siemens and Halske torsion galvanometer. The intensity of the current is $\frac{E^1}{10}$ = J ampères, $\frac{E}{J} - 10 = w\ i$ the internal resistance, E J = A the entire work, E^1 J = S the useful work in volt-ampères, and the electric effect $y = \frac{S}{A} = \frac{E^1}{E}$. If these two quantities are measured the other quantities, J, $w\ i$, S, A and y may be calculated.

In the accompanying diagram the electromotive force is represented (1 volt = 100 mm), the intensity of the current (1 ampère = 1,000 mm.), the internal resistance (1 ohm = 10 mm.), and the function of time (1 hour = 0·5 mm.). The element was measured down to 30 per cent. of its original useful effect, *i.e.* for 670 hours. During this time the mean values obtained were: E = 0·932 volt; J = 0·0846 ampère; $w\ i$ = 1·016 ohm; A = 0·0079 volt-ampère; S = 0·072 volt-ampère; y = 90·77 per cent. The entire quantity of electricity produced is 670 × 60 × 60 × 0·0846 = 204,055 coulombs, and as 1 coulomb consumes 0·0003376 gramme of zinc, the theoretical consumption of zinc would amount to 204,055 × 0·0003376. The real consumption was 86 grammes. From these results we may conclude that if the element is to yield $\frac{1}{80}$ ampère (*i.e.* the strength of current prescribed in the German telegraphs) it will maintain this intensity for 0·0846 × 670 : $\frac{1}{80}$ = 4535 hours, = 189 days, = 6 months. The materials cost — 200 grms. sal-ammoniac $\frac{16}{100}$ of 1s., and 86 grms. of zinc $\frac{1}{100}$s.



V. = Volt = 100, J. = Ampère = 1000, Wi = Resistance in Ohm. = 10 mm.

If the size is altered and some small modifications made in the construction these elements serve for currents of greater strengths. They are also made for interrupted use, only in this case the carbon is not coppered but saturated with readily oxidisable salts. There is nothing to prevent an almost unlimited use of this element, as the carbon does not wear out and the zinc and the liquid will serve for a year.—*Polytechnisches Notizblatt.*

MAQUAY'S VOLTAIC BATTERY.

FOR the following description and illustration of the invention of Mr. S. W. Maquay we are indebted to the *English Mechanic*. This journal states that, according to the inventor, the positive metal may be composed of two parts of lead and ninety-eight parts of commercial zinc coated with mercury and heated until the mercury is intimately mixed with each particle of the alloy. Although this alloy will give good results, it has been found by experiment that still better results will be obtained by the admixture of a small percentage of tin and mercury to the molten metal, which will ensure a more perfect amalgamation of the metals than if the mercury alone were simply coated on and the whole mass submitted to heat. The inventor prefers, therefore, to make the positive element of about one part, by weight, of mercury, two parts, by weight, of tin, two parts, by weight, of lead, and ninety-five parts, by weight, of common zinc.

The tin, being first smelted, the mercury is added and well mixed, and the lead being melted in a separate ladle is added and well stirred in. The zinc is melted in a separate ladle, and when at as low a temperature as it will properly melt at, the composition is added and well stirred in, so as to mix it completely, it is then either cast into rods or rolled into plates and used in any convenient shape. When formed in the shape intended for use, a convenient number of plates or rods are dipped into a bath of pickle made of two parts of sulphuric acid in twenty parts of water, and shaken until thoroughly clean, when they are plunged at once into a bath of mercury for a minute, taken out to drain and submitted to a heat of 100° Fahr. for five minutes, when they are again dipped into a pickle and again into the mercury, and again heated until each pound of metal has taken up about a quarter of an ounce of mercury, when it will be found that the plates having become amalgamated with the mercury, instead of simply plated, will require no further attention for the whole term of their life, care having been taken that the fluid used to excite them in the cells does not become mixed with the fluid of the negative element, as should that happen the plates would require cleaning.

For the negative element, carbon, platinum, &c., either in plates or in any other form, may be used, but a portion of such plates or rods is dipped into liquid sulphur, so as to leave a film of sulphur equal to form one-eighth to one-twentieth of the area of the plate or rod, or broken granules of sulphur are placed in the cells along with the plates or rods in the same proportion.

In the formation of the battery double cells are used, the inner one being of any suitable porous material, but preferably its two walls are formed of a mixture of two parts of carbon in fine dust, mixed with "slip" equal to six parts of the usual material of which cells are made, and baked at the usual temperature but without the presence of air, so that the carbon is not consumed. If the cell walls are made solely of carbon, difficulty is experienced in getting them to stand for any lengthened period. These porous cells, as will be seen in the figures, are formed by two flat plates, K, of the porous metal sliding in the ebonite battery case, A. Fig. 1 represents the battery in section, and fig. 2 is transverse to fig. 1.

The outer cells, G, are made in any convenient material such as glass, porcelain, wood, &c.; but vulcanite or ebonite, or any other such non-conducting light material is preferred. The cells are placed side by side, either in a circle or square, or in any convenient shape, and each cell has a communication, H, from one to the other within about half an inch of the bottom, and this communication between each cell is so arranged that it can be closed or opened at will by means of the plungers, E, it being understood that the negative cells have only a communication with other negative cells, and the positive cells can only communicate with the positive. This communication from cell to cell is made to enable them to be filled, emptied, or flushed out with water without interfering with or removing the battery plates, I, J, and the arrangement is

such that all the plates can be removed at the one operation so as to clean or renew them when required.

That is accomplished by attaching the tops of the plates, I, J, as well as the plungers, E, to a top plate, D, of ebonite or other material which may be lifted entirely out of the battery case, or may be raised slightly by the eccentrics, *c*, the shaft of which passes through the battery case. When the ebonite or other plungers, E, are raised there is free communication between the cells by means of openings, H. When the eccentrics, *c*, are turned down, the plungers, E (the ends of which are preferably coated with an admixture

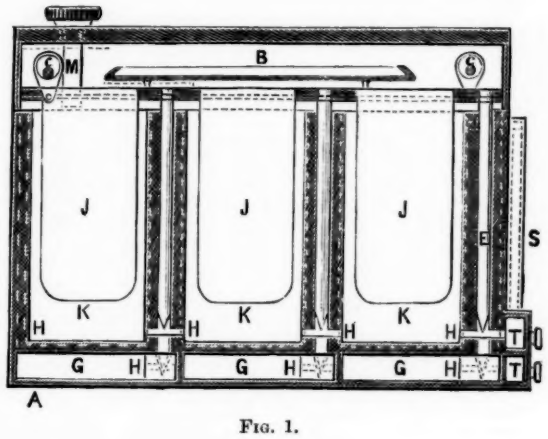


FIG. 1.

of tallow and paraffin), close the communicating channels, H, and the plate, D, which is provided with a suitable under packing, D^1, is also held firmly against the top of the cells, and prevents the liquid from escaping during transport. The connections between the battery plates are preferably above plate, D, so as to be clear of the acids. The solution for the outer or positive cell is one part of sulphuric acid in twenty parts of water; but a solution of common salt may be used.

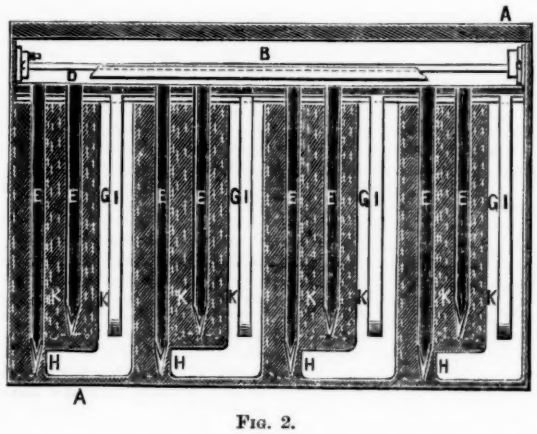


FIG. 2.

For the liquid in the porous or negative cells anything that will most readily absorb the hydrogen and prevent polarisation can be utilised, but when using carbon plates it is best to have a solution of bichromate of potash 35 to 40 parts, sulphuric acid 10 to 20 parts, and nitric acid 40 to 55 parts. A very small proportion of acid fumes escapes, and water is formed, but as a further precaution against the faint acid smell a small tray, B, made of ebonite, is placed inside the battery case and over the cells and plate, D, and in it are placed any absorbents which will most readily affect the acid fumes or water, such as pieces of pumice stone steeped in strong sulphuric acid and mixed with some powdered sulphur, when all fumes or vapours are at once taken up, if the proportions of the absorbents are properly regulated to the size of the battery. This battery may be conveniently formed out of ebonite, all made in one mould, the cells being in four rows, three in each row, end to end, the side walls of the cell being about $\frac{1}{8}$ inch thick, with the end wall joining two cells together $\frac{5}{8}$ inch thick. In the ends of each cell and along the bottom, are two grooves, $\frac{1}{16}$ inch deep, and placed $\frac{5}{8}$ inch from each other. Into these grooves the porous plates, K, are fixed firmly with an acid proof cement; this forms the porous compartment for each cell. In the thickened portion of the ebonite cell holes are drilled straight to within an inch of the bottom of each cell and then with a cone shape for the next half inch. In these holes the plungers, E, of ebonite turned into a cone shape at the end, are fitted accurately. Holes, H, $\frac{1}{8}$ inch in size, are drilled from one cell to the next, and when the plungers, E, are in place they completely stop the holes, H. When the plungers, E, are held up, the screw plug, M, may be removed, and the cells charged through the opening, while through the discharge, T (provided with the gauge, S), all the cells may be emptied and the battery flushed out.

REPORT ON THE PRIMARY BATTERY INVENTED BY MR. MAQUAY.

[COPY.]

195, Severn Road, Cardiff,
December 22nd, 1885.

THE PROPRIETOR MAQUAY BATTERY.

DEAR SIR,—I beg to report that in accordance with your instructions I have examined and tested this invention as fully as was possible consistent with the fact that Mr. Maquay, not having secured provisional protection, did not feel himself at liberty to disclose certain important features in its construction. With this reservation, I found Mr. Maquay willing and anxious to give me every information in his power and to afford me every facility for thoroughly testing his invention; and I may observe that although he appears not to pretend to deal with electrical work in the exact manner that electrical engineers are accustomed to do, he possesses a large store of practical knowledge of the subject.

As arranged with you, I proceeded to Mr. Maquay's lodgings at Chelsea at 11 a.m. on Thursday the 17th inst., where Mr. —— shortly after joined me. After some conversation it was arranged that Mr. Maquay should make up one of his small batteries for me to test in the afternoon. This was done, and the battery was tested from 4.30 to about 5.30 p.m., when, it being inconvenient to Mr. Maquay, owing to domestic arrangements, to continue the test that evening, it was arranged that he should have the small battery charged afresh at 9 a.m. the next morning, Friday, 18th inst. This was done, and the small battery was tested for seven hours continuously with one incandescent lamp of 5 candle-power nominal, and a very sensitive ammeter connected in the same circuit. Mr. Maquay also prepared a larger battery which was stated to contain three times the number of cells that were in the small portable battery. This larger battery was in a room upstairs, the current being led to a 15 candle-power incandescent lamp in the room in which I was sitting. I arranged one of Ayrton and Perry's voltmeters in connection with this circuit, so that I had an opportunity of observing the variation of both current strength and electromotive force on separate circuits and quite independently of each other.

The details of these tests are given below. The result upon my mind, so far as the tests have gone, has been to give me a most favourable impression of the battery; and this notwithstanding that, in common with most electrical engineers, I have a strong feeling against the employment of primary batteries for hard continuous work.

Perhaps it will make matters clearer if I detail the principal objections to the use of primary batteries and the difficulties met with where the work is heavy.

The primary galvanic battery consists usually of two plates of dissimilar metals, or of a metal and carbon immersed in some liquid, one of the component parts of which would have a greater affinity for the material of which one plate is composed than for the other. The best combination is one in which a component of the liquid acts very powerfully on one plate, and not at all, or very slightly, upon the other. Zinc and carbon in a dilute sulphuric acid forms such a combination.

The electric current is generated at the surface of the consuming plate just as heat is generated in a furnace by the combination of the carbon in the coal with the oxygen of the atmosphere.

The primary galvanic battery has been in use the last fifty years, but only where the work actually done, and the current furnished, have been very small, or the work has been more or less intermittent. Immediately the work was sought to be made continuous and of any magnitude, the following troubles arose —

1. The action at the surface of the consuming plate itself tended to weaken the current by the deposit upon it of another substance which tended, or might tend, to form with the plate and the liquid, a galvanic battery of its own, in opposition to the primary current; and further, the plate itself often contained impurities which also formed with the plate, of which mechanically it was a part, minute galvanic cells, very wasteful and very troublesome in action. This difficulty has been overcome in a great measure by the process of amalgamating the zinc—the metal most commonly used—*i.e.*, covering it with a film of mercury. Though the mercury appears to penetrate into the body of the metal, yet for very hard work this has not been successful, and hence the plates have to be re-amalgamated after a time.

2. The combination of one plate with a component of the liquid invariably sets free a certain quantity of hydrogen gas which appears in a very powerful state at the other plate. The quantity of this gas which is set free is directly in proportion to the work done, and it has the double property of forming with the otherwise passive plate a counter electromotive force which goes to reduce the strength of the primary current; and also the film of the gas which forms on the plate opposes the passage of the primary current by the electrical resistance which it offers. The result is, that unless some method is adopted of getting rid of this gas after it is formed, it gradually reduces the strength of the working current, and hence, even in batteries where the actual work done is light or intermittent, some method is always adopted of neutralising it, the most common being the placing in the neighbourhood of the negative plate of some salt or compound in oxygen gas and allowing the hydrogen gas to combine with it and form water.

3. Another source of trouble with the primary battery is the fact that various chemical actions are going on within the battery while it is working, and in some cases when it is not working, with the result that, in some cases, crystals are formed which collect around the plates and the porous division where one is used, thereby impeding the passage of the current and giving rise to further secondary actions, and, in other cases, poisonous fumes are generated which render it necessary to place the battery either under a flue or in the open air.

4. It also happens in the case of many batteries, and in particular of those that will usually furnish the most powerful current that, if not used for some time, they will be found when required to give a current to have lost the power of doing so until resuscitated.

5. The remaining objection to primary batteries for hard work is the cost of working, which may be divided into two heads:—(*a*) The cost of the metals and the liquids consumed. (*b*) The cost of the attendance.

From the above, which is the experience of every electrical engineer who has taken up this branch of the subject, it will be seen that the strong feeling mentioned above as being held by myself against the primary battery was by no means unwarranted, and the nett result may be stated in a few words, viz., no one has succeeded hitherto in arranging a primary battery that should be a commercial success when required to work hard and continuously. From the causes above stated (1, 2, 3 and 4), immediately you connected a battery to an incandescent lamp, though it usually gave a good light at first if you made the battery large enough, it quickly began to fail. Perhaps another point had better be stated here, viz.:—

6. In all primary and all secondary batteries hitherto produced, even under the very best conditions, the light or the current given when connection is first made, is usually largely in excess of that which the battery is calculated to furnish when doing its best work, in the sense of the work it will keep up longest, so that when using an incandescent lamp with a primary battery, as hitherto arranged, it has been necessary to strain the lamp for a time, or to insert an artificial resistance to compensate for the excess of electromotive force while it lasts, which is always more or less troublesome.

A further point may also be mentioned, viz., that in all the primary batteries which have been most successful, large space has been required if they were to work for any length of time, in order that a large supply of liquid and a large surface should be available.

It now only remains for me to state how far Mr. Maquay's battery has overcome the above difficulties. Owing to the fact, as before mentioned, that the invention had not been protected, and the limited time occupied by the tests, we are dependent on Mr. Maquay for information on several points, which, however, can be very readily verified later on if desired, and the tests that I was able to make will carry us a good way. For instance, it has been pointed out that the gross result of the points before referred to is, that the current given by a primary battery is usually in excess of its normal strength at starting and then falls more or less rapidly to a certain point where it remains fairly steady for a time, and then falls more rapidly until it gives out altogether; and that for the best results we require large surface and a large quantity of liquid.

If, then, we find a battery which on being connected gives out at once its normal current, and maintains it at an uniform strength for several hours, and if, further, the battery which accomplishes this feat is contained in a small space, we may fairly assume that most of the above difficulties have been overcome, otherwise we could not have such a result. In the tests above referred to, the ampèremeter used was a specially sensitive one, graduated to read $\frac{1}{10}$th ampère, and with such large divisions of the scale representing tenths of an ampère that it was quite easy to estimate to a second and occasionally to a third place of decimals.

The results were as follows:—

Test made of Small Battery, December 17th, 1885.

4.37 p.m.	Reading of ammeter		·950	ampère.
4.40 „	„	„	·925	„
4.46 „	„	„	·930	„
4.52 „	„	„	·935	„
4.57 „	„	„	·940	„
5.44 „	„	„	·940	„

Battery now disconnected.

Test of Small Battery made December 18th, 1885.

9.52 a.m. by my watch.	Reading of ammeter		1·0	ampère.
10.0 „	„	„	1·0	„
12.0 noon	„	„	1·0	„
12.30 p.m.	„	„	1·0	„
1.3 „	„	„	0·995	„
1.30 „	„	„	0·970	„
2.0 „	„	„	0·960	„
2.30 „	„	„	0·930	„
3.0 „	„	„	0·900	„
3.33 „	„	„	0·850	„

At this point I darkened the room so that the only light was that given by this lamp, and was able, with ease, to write an important letter.

3.52 p.m. Reading of ammeter 0·825 ampères.

The battery had now been connected six hours.

4.5 p.m.	Reading of ammeters		·800	ampère.
4.15 „	„	„	·750	„
4.25 „	„	„	·650	„
4.40 „	„	„	·600	„
4.52 „	„	„	·525	„

This makes up seven hours, and the light given from the lamp was now very faint.

Tests of larger Battery made December 18th, 1885.

11.40 a.m. by my watch.	Voltmeter reading		32·50	volts.
12.0 noon „	„	„	32·25	„
12.30 p.m. „	„	„	32·25	„
1.5 „ „	„	„	32·30	„
1.30 „ „	„	„	32·50	„
2.0 „ „	„	„	32·25	„
2.30 „ „	„	„	32·0	„

On disconnecting for a few minutes, the reading went up to 32·50 volts.

3.0 p.m.	Voltmeter reading		32·25	„
3.35 „	„	„	32·25	„

Disconnected for 15 minutes to allow of my darkening the room so as to observe the illuminating effect of the 5 C.P. lamp by itself.

4.5 p.m.	Voltmeter reading		32·25	volts.
4.35 „	„	„	32·25	„
4.50 „	„	„	31·75	„

The battery was left connected to this lamp and the voltmeter in position for Mr. Maquay to continue the test. The fall of $\frac{1}{2}$ volt would be absolutely inappreciable.

The small portable battery that furnished the current for the 5 C.P. lamp measured about 3½ inches cube, and weighed 7 lbs. complete including box and battery. This is the identical weight given for Mr. Swan's new miner's self-contained electric lamp, but I cannot help thinking that Mr. Swan's apparatus must weigh more than 7 lbs., as it certainly gave me the impression of being heavier to carry than the portable battery of Mr. Maquay. On the other hand Mr. Swan's battery occupies a larger space, and Mr. Maquay's battery could, in my opinion, by attention to a few of the details, be either reduced in size and weight, or if the same size be maintained or Mr. Swan's be taken as a standard, the amount of electrical energy available could be considerably increased. I had no opportunity of seeing the larger battery that was tested, but I understood from Mr. Maquay that it contained just three times the number of cells that were in the small portable battery, viz., 18 to 6, and that each cell contained rather more liquid, which would account for the improved behaviour of the battery.

I am of opinion, also, that many improvements may be made by careful attention to small details that will materially increase the duration of the battery of a given weight, when furnishing a given current.

The tests above given are conclusive evidence, in my opinion, that as far as they have gone, Mr. Maquay has overcome all the difficulties mentioned with the exception of No. 5.

In order to estimate more fully the value of the invention also, we require to know:—*a*. Whether any process similar to amalgamation is required in connection with the consuming plate, and what attention is required in that direction and how often? *b*. What labour, and what kind of labour, is involved in the renewal of the liquids that are used in charging.

It might very well happen that a battery would do all that has been described as having been done by Mr. Maquay's battery,

and yet be commercially valueless on account of the trouble and expense of renewing the plates and liquids.

On these points we are at present dependent on the information furnished by Mr. Maquay. He informs me that the consuming plate is of compound metal—I presume some alloy—and that when once placed in the battery it will go on working without requiring any attention until completely used up. That the process of renewing the plates consists of merely pulling out the old ones and slipping the others into their place; and that the plates in the portable battery before referred to will last for 14 days of six hours each; and, further, that the material is quite as cheap as zinc. Assuming these facts to be correct, it may be pointed out that a slight increase in the size and thickness of the plate, not involving much additional weight or space, would add to the duration of the available working current, and that the absence of the necessity for amalgamation or any similar process renders the material considerably cheaper than zinc.

On the point of the renewal of the liquids, formation of salts detrimental to the action of the battery, and noxious fumes, Mr. Maquay informs me that there are no fumes, and no salts formed, and that he proposes to attach a simple arrangement to the battery by means of which the exhausted liquids can readily be withdrawn and fresh liquids introduced. I confess that on this point I feel some anxiety, as I fear Mr. Maquay may have some difficulty in arranging the withdrawal and renewal in the manner proposed; but as he has been so successful in other respects, I would prefer to reserve my judgment on that point.

I may mention, however, that something similar to this has been done with other batteries, but only where they have been made on a large scale. With regard to the question of the attention required to the plates, I would suggest that Mr. Maquay should send me a small battery here and a certain number of spare plates, and a certain quantity of the liquids ready prepared, if that be convenient, and that I test them continuously day by day. If Mr. Maquay's anticipations are borne out on trial, in my opinion his battery will do what no other battery has done before, and the test of maintaining an incandescent lamp by its means will be sufficiently favourable, all things considered, as to commend itself for use in very many places where gas and oil are now used, and even, in special cases, in place of currents furnished by a dynamo.

It may, perhaps, be of advantage if I compare the electrical energy furnished by Mr. Maquay's portable battery with that furnished by Mr. Swan's portable secondary battery which was stated to maintain a 2 candle-power lamp for 10 hours.

In the case of the Swan battery the energy furnished in watts = 11 volts × ·4 ampères = 4·4 watts, and would give an allowance of 2·2 per candle. Mr. Maquay's battery gives 11 volts 1 ampère or 11 watts, and at 2·2 watts per candle should give about 5 candles, assuming the filament to be of the same construction; but by using Woodhouse and Rawson's hair filament lamp taking only 1¼ watts per candle-power, it should be capable of maintaining a lamp of 8·8 candle-power; so that it is clear that if the cost of working can be made the same or not appreciably in excess, the Maquay battery would be far superior to the Swan, inasmuch as for the same weight either more light or a longer life can be obtained; or for the same light, less weight—a very important point in the case of a miner's lamp.

In this matter I have taken into consideration the fact that Mr. Maquay's battery only ran for six hours while Mr. Swan's is stated to have run for 10 hours; inasmuch as by only taking from Maquay's battery the smaller current used in Mr. Swan's lamp a very much longer duration would result, and, further, to make the test a fair one Mr. Maquay's battery and Mr. Swan's should be constructed on exactly the same lines so that the useless weight and the wasted space in each should be the same. I may say, in conclusion, on this point that I have neither seen nor heard of any primary battery which would test as Mr. Maquay's did last week.

With regard to the value of the patent as distinguished from the value of the battery itself, I would strongly advise that very careful search should be made to see that it has not been anticipated; and as it is most likely that the success which Mr. Maquay has obtained is due to some small point which has been overlooked by other inventors, this point should be claimed so fully as to preclude all avoidance of the patent by the rival inventors who will rush into the field as soon as the matter is disclosed.

With regard to the field for which this battery is suited, I think it will be best that it should be clearly understood that it can only be an auxiliary to the dynamo, and not a rival. But with that reservation there appears to me to be a very large field for it—provided Mr. Maquay's figures are correct as to the duration of the plates—such, for instance, as the lighting of bedrooms at night. It would be a very great convenience to be able to have a light by merely turning a switch at one's bed side; and this is not possible with gas or oil, nor even with the electric light furnished by a dynamo, unless either the dynamo is driven all night or secondary batteries are used. The lighting of private carriages, of billiard rooms, dining and ball rooms, studies and numerous other applications will readily occur to everyone, as it appears from Mr. Maquay's statements that they can be made in any size and any form, and that the current may be taken from them all at once, or a few hours at a time; the battery remaining always ready for action for months together.

In conclusion, I beg most strongly to recommend Mr. Maquay's primary battery so far as I have had an opportunity of testing it.

I am, dear sir, yours faithfully,

SYDNEY F. WALKER,
M.S.T.E & E M.I.M.E., Assoc. M. Inst. C.E

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.*
WOODHOUSE AND RAWSON.
(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

(*Continued from page* 92.)

Saturday, May 15th, 1886.

Mr. ASTON, addressing his lordship this morning, said his learned friends Sir Richard Webster and Mr. Moulton and himself, and also the gentlemen who were assisting them, had had an opportunity of considering their position, and they were not surprised that his lordship had intimated with reference to the patents of Swan and Gimingham that he was prepared to rule that there was not that evidence of infringement which should go to a jury and therefore not evidence for a judge sitting as a judge of fact to consider.

The SOLICITOR-GENERAL desired to acquaint the Court with the circumstances under which he made the suggestion that there was no evidence of infringement of Swan's patent. He took up the point hastily either from one of his learned friends or from below and did not, perhaps, give it proper consideration. He did not feel that he should be dealing fairly with the Court if he did not say that it was quite possible that when the defendants came to be examined it might turn out that they would state something which the plaintiffs might properly and fairly say showed an infringement of Swan's patent. What he had said did not apply to Gimingham's; but he had no reason to suppose there was any infringement of Gimingham's.

Mr. JUSTICE BUTT: I quite appreciate your motives, Mr. Solicitor, but it seems to me that you are entitled without any breach of the high sense of morality and fairness to say: "I do not disclose what our patent is, but I say there is no evidence of the infringement of Swan's patent; I do not assert that there is no infringement, but I say there is no evidence." I have not given that decision. I have not come to an absolute conclusion upon either point, because before I decide absolutely that there is no evidence of infringementof Swan's patent I should like to look at the notes of what the evidence is. I do not understand at present that the charge of infringing the Swan and Gimingham patents is withdrawn.

Mr. ASTON: I submit to your lordship's ruling upon that matter and offer no further evidence.

Mr. JUSTICE BUTT: With the right of going to another Court, of course, to reverse it. If that is meant I must be careful what I rule. Not that I care very much whether any particular ruling is reversed or not, but I must not put the defendants, or the parties generally to the risk of a second prolonged enquiry for want of care. If something should have escaped my memory, and without hearing your statement I should hold to my opinion, which was pretty strongly formed, and should hold it wrongly, I should be committing a great injustice to all the parties.

Mr. ASTON: I think your lordship's ruling would be so well-founded that I should not be justified in reserving to myself for my clients any right of appeal.

Mr. JUSTICE BUTT: That is very fair. What I mean is this. I really do not care whether the Court of Appeal takes a different view from me or not on any particular point, but I do care very much to prevent doing an act without due consideration which may put the parties to all the expense of a further trial. That is what I want to guard myself against. My judgment, whatever it is, will not end here, it is pretty certain, on the main points.

Mr. ASTON: No, my lord.

Mr. JUSTICE BUTT: So far as that goes, so be it. But I must take care, if I can, that whatever Court ultimately decides this question finally shall have all the proper materials before it, and that the case shall not be sent back either on a misconception or for want of evidence. That being so, then, I think we must take it there is no evidence of infringement of Gimingham's or Swan's patents.

Mr. ASTON: I quite accept that, my lord.

The SOLICITOR-GENERAL: Whatever comes out in the evidence, my learned friends and I will be relieved from any charge of bad faith to the Court.

Mr. JUSTICE BUTT: I have no doubt you are quite right in saying what you have said, but I think it was supererogatory.

The SOLICITOR-GENERAL: Then my learned friend will go on upon Edison's patent?

Mr. ASTON: Yes, as if Edison's were the only patent in the case.

The SOLICITOR-GENERAL: Do I understand my learned friend to go on the first claim as well as the second?

Mr. ASTON: I think so.

The SOLICITOR-GENERAL: I will not argue it now. I cannot withdraw from the position we have taken up with regard to Edison.

Mr. JUSTICE BUTT: I do not ask you. It is immaterial to decide whether Swan's and Gimingham's are valid patents. I do not hesitate to say that I have rather a strong opinion about it, but I do not propose to decide that unless it is to be carried further, because it is unnecessary, and I do not know why I should go out of my way to declare a patent invalid unless it arises in the case. Then they are out of the case?

Mr. ASTON: They are, my lord.

Mr. JUSTICE BUTT: Now as to Edison's patent, I do not ask you to make any admission whatever, but I presume the Solicitor-General and those who represent the defendants have a right to say, have they not (I am not clear), with reference to the first of Mr. Edison's claims, "There is no infringement, and I call upon the Court to say so."

Mr. ASTON: No, my lord. The infringement cannot be split up. It is a general charge.

Mr. JUSTICE BUTT: Unless there is no evidence of the plaintiffs' case, I must hear the evidence if I think it is a *primâ facie* case.

The SOLICITOR-GENERAL: I thought we might shorten the scientific evidence if we could narrow the issue, but I quite acquiesce in your lordship's ruling.

Prof. EDWARD FRANKLAND, examined by Mr. Macrory, said he had been for the last twenty years Professor of Chemistry in the Royal School of Mines and the Normal School of Science, South Kensington. He had been acquainted with the science of electricity a great many years, and had practically experimented with the electric light, having lighted his house at Reigate for about four years with incandescent lamps. He had taken a great deal of interest in the modern development of electricity, and had read and considered the specification of Mr. Edison of November, 1879. He had heard Sir Frederick Bramwell's description of Edison's patent, and agreed with it.

Mr. JUSTICE BUTT: I should like to ask a question here for my own information. This exhaustion of the vessel so that only one-millionth of an atmosphere is left—Sir Horace Davey spoke, in his address yesterday, as if the Sprengel pump would do that without any heating of the material in the tube. Is that so?

Mr. ASTON: It is a question of degree of exhaustion. There is no doubt about that.

Mr. JUSTICE BUTT: The Solicitor-General in his argument stated and argued on the assumption that Sprengel's pump, without any heating of the carbon or other material in the globe, would exhaust it to that extent. Is that so?

Mr. ASTON: No doubt it would, and make a practically useful lamp. It is a question of degree.

Mr. MACRORY: The difficulty would be this. I have no doubt that the Sprengel pump, if used, would get rid of the atmosphere down to that small extent, but then when the electric lamp was lighted that would soon fall away by reason of the occluded gases.

Mr. JUSTICE BUTT: That is what I want. Let us suppose that there was no material besides the glass itself, that there was no platinum and no carbon, then will it exhaust down to one-millionth of an atmosphere?

WITNESS: That is exactly so. It would exhaust down to that degree, and that exhaustion would practically continue till the carbon (supposing carbon to be inside the vessel heated, and then the vacuum would be impaired.

With the carbon inside it is not exactly an exhaustion to a millionth of an atmosphere?—That is rather a metaphysical question, my lord.

It exhausts the air in the vessel, but if the carbon is in it is in addition to the one-millionth of an atmosphere?—No, it would not be in addition, because it would not affect the barometer.

Mr. MACRORY: Are not the occluded gases contained in the carbon, so sealed up in it that it requires the electric current, or some intense heat like that, to discharge them?—Yes; the moment you begin to heat the carbon the gases begin to come out, and you get them more thoroughly out the more strongly you heat it.

Do you consider that the alleged invention at the date of the patent, November 18th, 1879, was a new invention?—No, I do not.

Have you made yourself acquainted with the prior specifications and publications mentioned in the defendants' notice of objections?—Yes, I have. I have read them through carefully.

Will you turn to King's patent of 1845, No. 10,919, and tell me in your own language what you find described there?—In the first place, I find described a method of obtaining light by the incandescence of a continuous carbon conductor. Secondly, I find that on account of the combustibility of this carbon conductor it must be placed in a very perfect vacuum. He prescribes the Torricellian vacuum, which up to the present day is almost as perfect a vacuum as can be obtained, supposing the other conditions to be favourable to maintaining that vacuum, but it is evident that there will be two reasons why this vacuum would not be so perfect as it ought to be. The first would be the difficulty of excluding a film of atmospheric air adhering to the outside of the carbon conductor; and secondly, of course, that fatal circumstances of the occluded gases given off when the carbon is ignited.

Mr. JUSTICE BUTT: I see he says: "On account of the affinity this substance has for oxygen at high temperature, it is necessary to exclude from it air and moisture." That means that it is necessary to exclude all the air you can?—He was not aware of occluded gases, apparently; or, at all events, he disregarded them.

Mr. MACRORY: Do you find also in this specification any reference to the size of the carbons to be used in the lamp?—Yes; it begins at line 38, page 3: "That form of carbon found on the interior of coal gas retorts, which has long been used as well suited for this purpose, and may be worked into the form of either small pencils or thin plates by the aid of the saw and file." So that he was aware of the advisability, at all events, of having a very thin piece of carbon.

Will you look at the drawing, fig. 2. First let me ask you, is your view of this that it is an incandescent lamp?—No doubt.

Mr. ASTON: I do not deny that.

Mr. JUSTICE BUTT: I suppose that the word "continuous" settles it?

Mr. ASTON: The arc light, I believe, is always used in open air.

WITNESS: Usually; but there are patents for using it in vacuum. It is known, and has long been known, that it may be used in vacuum.

Mr. MACRORY: Will you point out where the carbon strip is in fig. 2? I think he calls it a carbon strip?—Yes. I take it that this fig. is meant to represent either a thin plate of carbon or a very thin plate of platinum, which is also described.

Mr. JUSTICE BUTT: I think he refers to that as carbon alone, and not as platinum or carbon.

WITNESS: Yes; that is so.

And the words are "pencils or thin plates."—I do not think c in the drawing would represent a thin pencil, but it would correctly represent a thin plate.

Mr. MACRORY: Will you go now to Roberts's specification. What do you find in that specification?—I find this described at line 20 of page 11: "Another part of my invention consists of a mode of obtaining electric light by passing a current of electricity through a thin piece of graphite, coke, or charcoal, or other infusible body being a conductor of electricity while it is enclosed in a vacuum—a space not containing any oxygen or any other matter which can cause the combustion or destruction of it when brought into an incandescent state by the action of the current of electricity." He says he has shown an elevation or a side view of an apparatus which may be used for that purpose, but he says: "I desire it to be understood that I do not claim any of the elements or parts of which this apparatus is composed apart from the combination thereof." But all the parts were, in fact, really known. He then goes on to describe this apparatus on page 12, at line 4: "Now the mode of operation with this apparatus is as follows: a piece of very thin graphite about half an inch long, half an inch wide, and as thin as conveniently can be made, is fastened at each end into the clips, h and h_1, and firmly secured; the globe, g, is screwed air tight upon the pillar, b, the stop-cock, s, is opened, and the whole apparatus, by a screw at the bottom of b, screwed down upon an air pump or exhausting syringe; by this the air is drawn out of g, and as perfect a vacuum as conveniently can be made is obtained; when this is done the stop-cock is shut, and the apparatus is then removed to its stand, a, and a galvanic battery is put into connnection with it by the binding screws, f, f_2, the electricity passes through the rods and thin piece of graphite, j, which becomes white hot from the passage of the electric current; and no combustion will ensue if the vacuum be perfect, and no matter within the globe to cause combustion of the graphite, or if the graphite be not otherwise destroyed, the light continues as long as the electricity flows through the graphite in sufficient strength. And with respect to this part of my invention, I claim the production of light by passing electricity through a thin infusible body being a conductor of electricity, in manner hereinbefore described." That is certainly, to my mind, a description of an incandescent lamp.

Do you find in that a piece of carbon enclosed in a vessel which is exhausted of its air to a high degree?—Yes. It is not hermetically sealed, but it is made as tight as cement, I suppose, could make it.

You find there is a vacuum created, do you?—A vacuum is created; not so good as the Torricellian vacuum, but still as good a vacuum as an air pump can give.

You find a more perfect vacuum described in the earlier patent?—Certainly.

Can you tell us how thin it is possible to get graphite?—I should think it would be quite possible to work it down with care to $\frac{1}{3\,2}$nd of an inch.

May I ask you now what graphite is?—Graphite is essentially carbon. I might perhaps mention that there are three distinct forms of carbon known. One is charcoal, which is a very poor conductor of electricity and does not conduct enough to be useful for this purpose; secondly there is graphite, or graphitic carbon, as it is sometimes termed, which is a fairly good conductor of electricity; and thirdly there is diamond, which is a non-conductor of electricity.

Mr. JUSTICE BUTT: I suppose something depends on the working of it down. Something must depend on the width, must it not?—Certainly.

What width do you say you could work it down to?—Well, if I were set to make the smallest possible carbon of that kind I dare say it would be possible to work it down to say the $\frac{1}{10}$th part of an inch wide; but then it would be so exceedingly fragile that I do not think it could be employed.

That is the material thing. I mean so as to be employed. How thin could you reduce it? Could you employ it at $\frac{1}{32}$nd part of an inch?—I think so.

At what width?—I should say a quarter of an inch.

Mr. MACRORY: Will you kindly turn to the figure in Roberts's specification, fig. 5, I think it is. Will you describe in your own way what you find shown there?—I find there a glass globe with a neck, very similar in shape to the incandescent lamps now in use. The neck of this is closed by a cap, and through that cap pass two conducting wires.

Mr. JUSTICE BUTT: Is that cap of metal?—That cap, I take it, is metal, with some kind of cement by which it is secured air tight to the globe. Through this cap and insulated from the metal cap pass two conducting wires into the interior of the globe to about the middle of it; across, between those two wires, is then placed a strip of graphite which is to be afterwards made incan-

descent. That is *j*. Then there are two binding screws marked *f*, I think, and the wires as shown in the figures passing from these binding screws to the battery. I need scarcely mention that in those days the battery now called a primary battery was the only practicable available source of electricity, and that is no doubt one reason why the development of this form of lighting was delayed so long.

Mr. MACROBY: Your view is that it was the introduction of the dynamo machine which gave an impetus to electric lighting?—Yes, certainly.

Do you find in that drawing and in the letterpress a vessel of glass described, containing a carbon attached to conducting wires?—Yes.

Mr. ASTON: No, they are specially called rods and not wires.

Mr. JUSTICE BUTT: What I want to get at is this: does it show anything identical with the lamp in suit, and if not in what does the difference consist, and how far that is important.

Mr. MACROBY: Do the drawing and letterpress show and describe anything identical with the lamp shown and claimed by Edison?—In some respects they are identical, but in several important respects they differ. There is first a vessel of glass; there are two conductors (whether we call them rods or wires I take them to be practically identical) in the two lamps; and there is the piece of carbon (I will not give it a name) which is ignited by electricity. Those are the points of similarity.

Mr. JUSTICE BUTT: Are the points of difference important?—Oh, I think they are important. They are these: the vessel is not entirely of glass, and consequently in such a vessel you cannot make and maintain as described in the specification a good vacuum. Those I consider to be the essential points of difference.

Mr. MACROBY: Do you find in this a conductor of high resistance?—I do. Compared with the rest of the apparatus the graphite is of very high resistance.

I will go now upon the question of high resistance to the specification of Mr. Lane-Fox, No. 3,988 of 1878. Will you state what you find described there?—I find that Lane-Fox provides for the production of an incandescent light by the passage of an electric current through a thin strip of wire or some suitable material, and he says, "for which purpose I prefer to use an alloy of platinum and iridium. The electric lamp in which the light is produced therefore consists of two conductors insulated from one another having this strip or wire between them and in contact with each." Then he goes on to say: "The material or alloy employed should be capable of standing as high a degree of temperature as possible without fusing, volatilising, or falling to pieces; it should also have a high specific resistance. The higher the temperature to which the material can be raised the more economical will be the light produced, that is, the light will be greater in proportion to the force or energy expended, inasmuch as the radiant energy proceeding from the surface of the material will be more and more luminous as the temperature increases. In order to prevent the deterioration of the material when incandescent, I sometimes surround it with an atmosphere of nitrogen gas. The quantity of light will be proportional to the extent of the luminous surface. The resistance of the luminous material and its extent of surface should therefore depend on the amount of light it is required to give and the electromotive force used. Speaking broadly it may be said that the resistance of the luminous conductor should be so adjusted or fixed that the electromotive force of the mains to which it is attached is just sufficient to develop within it the strength of current necessary to raise it to the right degree of incandescence. In order that the electric force may be conveyed at a high tension, that is, having high electromotive force so that there may not be very great loss from the resistance of the conducting mains or conductors, I make the lamps when I use an alloy of platinum and iridium of lengths of fine wires so that I may get a high resistance without having a large extent of luminous surface."

What do you find there that resembles the lamp which is the subject of the claim of Mr. Edison?—If I am to take carbon as one of the suitable materials included by Lane-Fox in this specification I should say that the resemblance is then complete. But if I am to take platinum as the material which is represented in this lamp in fig. 1, then the only point of difference is in the incandescent conductor being platinum instead of carbon. Perhaps I may be allowed to add that in my opinion Lane-Fox in this specification gives nearly all the cardinal points which have to be observed in the construction of a good incandescent lamp, and more clearly than anybody ever did before or has done since, I think.

There platinum is the conductor used?—An alloy of platinum and iridium, which fuses at a still higher temperature than platinum.

Mr. JUSTICE BUTT: I do not think it is to be of carbon, or he would have mentioned it.

WITNESS: It is remarkable to me that he does not in this specification mention carbon.

If he thought it applicable, as a man possessing some science, I suppose he would have put it in?—I think he cannot have known what had been previously described about the possibility of making thin carbon.

Therefore he left it out intentionally. I do not think it is one of the other materials he contemplated using. If it could not be made he would not contemplate using it.

Mr. MACROBY: Was the manufacture of thin carbon known at this time?—Oh, yes; before that patent several years.

Was it known as a suitable material for the conductors of an electric lamp?—Yes; I think there can be no doubt.

Now we will go to Lane-Fox's of 1878, No. 4,043. I will ask you there to look at page 3 of the specification commencing at line 8; and will you tell his lordship what resemblance you see between what is described there and the lamp described and claimed by Edison?—There is this resemblance, that this conductor would consist practically of carbon; that is, it would consist of asbestos continuously coated with carbon.

Mr. JUSTICE BUTT: "Saturated or impregnated" are the words he uses.

WITNESS: Yes; but it must be continuous carbon, because asbestos itself will not conduct electricity. Therefore the active material here is carbon, and it must be continuous carbon or the current would not be transmitted; but it is asbestos essentially coated with carbon that he uses, and this rather convinces me of what I surmised a minute or two ago, that he did not know of a proper mode for carbon.

He did not know of carbon at any time, and so he adopts this plan that may be very good?—It may be a step on the road to, if it is not as good as carbon.

Mr. MACROBY: Will you look at fig. 2 there and say if you see any resemblance in the figure itself?—Yes, there is a very strong resemblance in many ways to the incandescent lamps at present in use.

Will you please pass on to the patent of Mr. Lane-Fox of November 14th, 1878, No. 4,626. Will you tell his lordship what you there find?—I find here described platinum, iridium, iron or other metal to be used either pure or alloyed with some other material or materials; and he says he prefers to coil a long strip or wire in the form of a spiral. That resembles Edison's, inasmuch as it contains a spiral. Then it goes on to say that the length and thickness of the spiral depends upon the intensity of the light required, and so on.

Let me call your attention to line 9 of page 1 of that specification: "I make use of a thread, platinised or iridised or carbonised, of asbestos or other suitable material supported between two conducting terminals." What do you say to that?—That so far as the carbon is concerned, it is the same material that we were speaking of just now. Carbonised asbestos I take to mean asbestos covered with carbon, or coated or saturated with carbon.

Does he say that he enclosed the whole of that in a glass?—Yes, he does.

Mr. JUSTICE BUTT: And exhausts it?—Yes.

Mr. MACROBY: There is more than that. The platinum supports are fused?—Yes; it is a hermetically sealed vessel.

Through which the conducting wires pass?—Yes.

Is that covering made entirely of glass?—I take it that it is.

Do you find that he makes use of the Sprengel pump?—Yes.

Does he thereby obtain nearly a perfect vacuum?—Yes; but of course this vacuum would be liable to deterioration afterwards on the admission of the conductors.

Does that describe an incandescent lamp there in your opinion? I mean that paragraph commencing at line 17 on page 1, and ending at line 14 on page 2.—Certainly.

Mr. JUSTICE BUTT: That was agreed, I think; but you come to something different from an incandescent lamp directly afterwards?

Mr. MACROBY: Now come to the next paragraph. Did you hear Sir Frederick Bramwell's evidence about that paragraph?—I did.

Do you agree with that?—I entirely agree.

Mr. JUSTICE BUTT: It is not an incandescent lamp?—No, my lord.

Mr. MACROBY: Will you go back again to line 9, page 1. Do you see there the words: "Platinised or iridised or carbonised asbestos"?—Yes, or other suitable material. I do not see that we get any further there than we did in his former specification.

But he speaks below of coiling a long strip of wire into the form of a spiral. At all events he had some material in his mind in the way of a suitable material that was capable of being made into the form of a spiral?—I think he must have had that in his mind.

Sir RICHARD WEBSTER: Does he tell us in the specification what that material is?

Mr. JUSTICE BUTT: That you had better not answer.

Mr. MACROBY: I am not to be led away. Have you read the patent of Pulvermacher of 1878, No. 4,774?—Yes, I have. I find here described a method of making a conductor of carbon so that it can be wound into a spiral and afterwards carbonised, and a particular mixture is prescribed from which the pencil or filament is to be made. The mixture which is described by Pulvermacher is identical with one of the materials prescribed by Edison. Secondly, Pulvermacher describes a process of treating this material by which filaments of almost any degree of fineness may be readily obtained. And I have myself made filaments by this process, which, I think, are fine enough for any incandescent lamp.

Mr. JUSTICE BUTT: A filament can be made of any required thinness, do you say?—Of any required thinness down to the specimen I have put before your lordship. You can see that that is a very fine filament, that is perfectly flexible and can be bent in any form; and after carbonisation it is fit for use in incandescent lamps. That specimen before your lordship is not carbonised.

It is capable of carbonisation?—Yes; and I have specimens of it carbonised.

He speaks of a heating operation.—Yes, that is carbonising.

I think the other side admitted that the heating referred to there is carbonisation?

Mr. ASTON: Yes, my lord.

WITNESS: As there is a little difference in the description of

the material in the two specifications, I ought perhaps to explain why I say the two mixtures are perfectly identical. Pulvermacher says: "Take fine powdered pure charcoal mixed with tar and pitch." Edison says: "I have also discovered that carbon filaments may be made by a combination of tar and lampblack, the latter being previously ignited in a closed crucible for several hours and afterwards moistened and kneaded until it assumes the consistency of thick putty." Lampblack after ignition in this way constitutes one of the purest forms of carbon known. Tar contains pitch as one of its constituents; therefore Pulvermacher uses tar and pitch and carbon, and Edison also uses tar and pitch and carbon, inasmuch as his tar contains pitch. There may be more pitch in Pulvermacher's mixture than in Edison's, but in other respects they are identical. (Prof. Frankland here produced specimens of filaments made by him, following exactly the description given in Pulvermacher's specification, one before and one after carbonisation. He also produced a lamp made according to his instructions, and containing a Pulvermacher filament.)

WITNESS: Your lordship will see that that filament is quite elastic.

Mr. JUSTICE BUTT: I have tried it; I see it quivers. This is a lamp with a conductor made of the same materials?

Mr. MACRORY: And made in the same way.

Sir RICHARD WEBSTER: You must not say that; you have no right to say it is made in the same way.

Mr. CHARLES: The witness says so.

Mr. MACRORY: Let there be no mistake about it.

Mr. JUSTICE BUTT: Is it so? I thought Pulvermacher's was a spiral. How can it be made in the same way?

Sir RICHARD WEBSTER: It is a coil around a core which is never taken out of it. I do not want it to appear on the note that Dr. Frankland says something was made according to Pulvermacher's specification which was not so made.

Mr. JUSTICE BUTT: No doubt. It is a lamp of Pulvermacher's material, but it is not made in the way Pulvermacher suggests, because he suggests a spiral. It is not right to say that the lamp was made in the same way.

Mr. CHARLES: If my friend said that, he withdraws it.

Mr. MACRORY: There is no witchery in making a thing in an arc.

Mr. JUSTICE BUTT: But there is witchery in being exact. It is not a lamp made in the same way.

Mr. MACRORY: It is a lamp made of the same materials.

Mr. JUSTICE BUTT: Yes. That I have got.

WITNESS: That is made by drawing it through a draw plate, which is prescribed by Pulvermacher for making such a thing.

Mr. MACRORY: Now we will go to the specification of Scott of 1878, No. 861. Will you tell my lord in what way that resembles what has been described by Mr. Edison?—It is substantially the same material. It consists of finely powdered carbon, with thin flour paste, or thin starch paste, so as to produce a plastic mass having a consistency suitable for moulding by dies and pressure, and this mass he states may be rolled into threads, pencils, or whatever I may be allowed to call them.

Mr. JUSTICE BUTT: Strips or ribbons?—Yes; and he speaks also of dies.

He uses also another word, "core."—He also says that this may be made by forcing the plastic mass through a hole in a draw plate, which is just what Pulvermacher says. I have not made any filaments by this process, but I have no doubt it could be successfully used.

Is there anything which carries you beyond Pulvermacher, on the road towards, or to Edison?——

Mr. MACRORY: There is a case here, is there not, described of fibrous material?—Yes; I think he says so somewhere.

Page 2, line 8: "Fibres of hemp?"—Yes; he says he takes the carbon or carbon mixture and incorporates these with fibres of asbestos or fibres of hemp or other materials, and dries them with heat.

Does that convey to your mind anything which resembles that which is described in Edison?—Yes, it does; but I do not think so completely as Pulvermacher.

Mr. JUSTICE BUTT: Is this an incandescent lamp?—No, my lord.

Part of it looks as if it were.—It is merely for arc lighting, I think.

It comes to this, that for an arc light he forms, whatever you think them, the bands or ribbons of the same material, and in the same way as described by Pulvermacher.—I do not think the bands are formed in the same way as Pulvermacher forms them, but he uses a very similar mixture for incorporating those bands.

I think you said he passes them through a draw plate?—Yes; he describes pressing them through a draw plate, and it is not very evident how he used that, after it is pressed through a draw plate, for the arc light.

Mr. MACRORY: In this specification of Scott's am I right in saying that he uses rolling?—Yes; that is one of his methods for getting a fine rod or thread of any degree of fineness he requires.

Will you explain next any similarities you find in the specification of Harrison, No. 3,470, of September 2nd, 1878?—He says his invention relates: "Secondly, to the production of flexible carbon or flexible metallised carbon burners of any required thickness and length. This I effect by using threads or filaments of silk, cotton, or other suitable flexible material, which I first treat with acid, such as nitro-sulphuric acid, to render it more perfectly combustible, and then coat with carbon or metal by rubbing, pressure, or otherwise incorporating with them powdered plumbago or other carbon, or with metal compounds by electrotype or other process, and then form such coated or treated strands into a cord or rope of any required dimensions. A convenient method for flexible burners is to wind them on a rotary axis or drum, which by its rotation would advance the burners each to the mouth of a tube, or to a point where they would be consumed."

This is an arc light?—Certainly.

Mr. JUSTICE BUTT: What would be the result of making as he describes?—To complete his process as he describes you would get a kind of flexible rope that could be fed into the lamp, and thus prevent the necessity of continually renewing it.

Would it be a successful process?—I think one might conclude that it would; but whether it would be economically better than the use of the ordinary carbons I am not prepared to say. I have never seen the process in action. I have seen flexible carbon used.

Mr. MACRORY: I need hardly ask you whether the carbon that is produced there would be flexible or not?—I think very likely it would, but I cannot say positively. It is rather a complicated process that it passes through, and I would not like to say positively whether at the end of it the carbon itself would be flexible or not. Certainly the whole thing is flexible, but then the carbon, it appears to me, is deposited upon something else, and that something else may be flexible. I am not at all prepared to say that that carbon itself is.

Now I pass on from that to Van Choate, No. 4,388 of 1879. Let me first ask you whether you are of opinion that the lamp that is the subject of that specification was an incandescent lamp?—I have read the specification carefully. It is not very clearly worded, but I have gathered the decided impression that he means the whole thing for an incandescent lamp and not an arc lamp.

Mr. JUSTICE BUTT: It must be a model specification that leaves a scientific gentleman in doubt as to whether it is to be applied to an incandescent or to an arc lamp.

Mr. MACRORY: I am afraid there are a great many model specifications then.

WITNESS: The source of confusion is the use of the word "arc" in this specification. It speaks of "arcs of paper or ribbon." Again, it speaks afterwards of the electric arc or light. If my interpretation be correct, when he speaks of electric arc or light he means this arc of paper or ribbon, or other material which is rendered incandescent. There would be no possible use for arc lighting of these spiral globe-shaped illuminators or burners. That has a strong influence with me in the interpretation.

Would that be consistent with incandescent lighting?—Certainly that would be a useful burner for an incandescent lamp.

Referring to the words on lines 27, 28 and 29, would they appear to point to arc or incandescent lamps?—It is not very decided either one way or the other.

Mr. JUSTICE BUTT: That means that you may take your choice?—On line 23 he says the material may be formed into arcs. I cannot understand an arc being used for an arc light; it is impossible.

Mr. MACRORY: Now will you point out to his lordship what you think in that specification resembles what has been described and claimed by Edison?—This man seems to have known of a process by which he could coil or wind certain substances into spirals of arc shape, and spiral globe-shaped illuminators or burners.

What do you mean by spiral globe-shaped?—What I understand by a spiral globe-shaped burner is one composed of a filament wound round a globe and afterwards carbonised. That, I think, would form a very good illuminating conductor for an incandescent lamp.

So that each succeeding fold is larger than the one preceding it?—Yes; that is globe-shaped.

Mr. JUSTICE BUTT: Carbon is one of the materials he uses, but when he comes to talk about it he calls it "This metallic or semi-metallic substance."

Mr. MACRORY: If your lordship looks at line 16 you will see carbon is one of the materials.

Mr. JUSTICE BUTT: Carbon is one of the materials, but I do not understand from this that he proposes to make his burner of carbon alone, because I do not understand why he speaks of metallic or semi-metallic substances or materials.

Mr. MACRORY: I read it in this way: "This metallic or semi-metallic substance or material," meaning the other things, because that must be so when he mentions carbon above, "asbestos or carbon, or any combination of them."

Mr. JUSTICE BUTT: That is your reading of it.

WITNESS: It would not be altogether incorrect and unscientific to speak of graphite carbon, such as was used for these purposes, as semi-metallic.

Mr. MACRORY: I am further confirmed in my view by what I read on page 2, line 20: "To render incandescent the carbon, metals, or other substances used for giving or developing the light." Clearly carbon is there alone. Then on line 56: "To pass either through the carbon, metal, or other substance."

Mr. JUSTICE BUTT: I think you are right.

Mr. MACRORY: Now will you tell his lordship what you consider is disclosed in this provisional specification that resembles what has been claimed by Edison?—The form of spirals, the carbon.

Mr. MACRORY: A spiral globe-shaped is shown in Edison's patent; there is no doubt as to what it is if you look at fig. 38.

Mr. JUSTICE BUTT: Does he say anything about thickness or thinness in this?—No, my lord. He says at line 16, page 2: "In carrying this part of my invention into practice for electric lighting I first ascertain or determine the number and power of the lights, lamps or illuminators to be used in each circuit. I then ascertain and determine the amount of electrical resistance that will be required at each lamp or point of illumination to produce the electric arc or light; that is to say, the amount of resistance necessary to render incandescent the carbon, metal or other substance used for giving or developing the light."

Do you say, as that depends on substance, that that must mean a thin one?—Yes.

Mr. ASTON: Kindly read to the end of the sentence, and you will see that that is so.

WITNESS: "The sum of these quantities of resistance added to the resistance of the wire or conductor will be the total resistance in the circuit; that is to say, the strength of the electrical current required to be generated to produce the desired number and intensity of the light." I do not see that that modifies what I say.

Then I did not catch your answer.—I said that the amount of resistance in the illuminating part of the conductor would determine the sectional area of that conductor, or its length at all events.

You say that independently of this, but this provides for desired number or intensity of lights.

The SOLICITOR-GENERAL: You will cross-examine presently.

Mr. MACROBY: Let me call attention to page 1, line 22, and see whether that conveys to your mind the idea of the size. "This metallic or semi-metallic substance or material is preferably made into wire or ribbon of the proper size." For forming into a spiral?—Yes.

I do not know whether you find in Edison's specification any description of the size of his fibre.—He says: I think that you may make a filament of a certain size, one seven-thousandth part of an inch in diameter. He does not say that he does make it.

Have you seen exhibited here the lamp that we have called the Swan Newcastle lamp?—Yes, I have.

Have you examined it?—Yes; that is, I have merely examined it in my hands. I have not made any experiments with it.

Do you find there a vessel made entirely of glass?—Yes, entirely of glass.

Do you find that it contains a continuous carbon attached to conducting wires?—Yes.

Do you find that those wires are sealed through the glass?—Yes.

I do not know whether you can see whether that vessel is exhausted or not?—That I could not tell, but from the appearance of the deposit on the inside I should say that it had been exhausted.

Would the fact of its having emitted a brilliant light convey to your mind that it had been exhausted?—If it had emitted a brilliant light for an hour, as I have heard stated here, that would be tolerably conclusive, I think, that it was in vacuum.

Did you see any, and if any what, resemblance between that and the lamp described and claimed by Edison?—I see a resemblance perfect throughout in that lamp, until we come to the diameter and shape of the carbon conductor. The diameter of that conductor is very much larger than the diameter of the Edison conductor, and it is straight instead of being a curved or spiral conductor.

Mr. ASTON: I have never disputed this.

Mr. JUSTICE BUTT: I think the witnesses on the other side have said the same—except in those respects. You cannot have better evidence than your opponents give.

Mr. MACROBY: Now, have you read the extract from *Comptes Rendus* relating to what we have known here as the Sidot process?—Yes.

Have you read it in English, in French, or in both?—In both.

Will you tell me what you understand is the process which Sidot describes there? First of all, let me ask you is it all one process, or to your mind is it more than one?—I was going to say there are two distinct processes described by Sidot, which have been a little mixed up together here. The first process consists in heating pieces of wood, thread, cotton, paper, silk, and various other similar things to redness in a porcelain tube and passing over them, during the period of their carbonisation and afterwards, a current or vapour of disulphide of carbon, or a current of the vapour of spirit of wood, carburetted hydrogen, &c. He states that you are to heat the tube slowly and gradually up to red heat for the space of about an hour. That is his process No. 1. Process No. 2 consists in this——

Mr. JUSTICE BUTT: Is this part of the process relied on? If it is not, it is not worth while going into it.

The SOLICITOR-GENERAL: We rely on the first principally, but we also say the second process provides a practicable mode of procuring carbon filaments.

Mr. JUSTICE BUTT: You are going to vary Prof. Dewar's evidence?

Mr. MACROBY: Yes.

WITNESS: The second process consists in passing vapours of methylated alcohol over wood at a red heat in a porcelain tube; this vapour becomes decomposed, and at the same time the interior sides of the tube are covered with a very singular carbon. This in fact presents itself in the form of filaments one centimetre in length, consisting of a kind of silky and frothy coke white like silver. Then he goes on to say that these filaments appear to be formed of little balls touching one another.

Did you hear Prof. Dewar give a description of an experiment which he had tried, as he alleged, according to Sidot's process? I did not hear Prof. Dewar give his evidence in chief; but I have read the evidence.

Will you tell his lordship to what you attribute the failure that Prof. Dewar says he obtained?

Mr. JUSTICE BUTT: He does not say he obtained a failure. He says he obtained a success; that is, exactly what Sidot describes.

Mr. MACROBY: I want to ask Prof. Frankland whether he thinks that was the substance that Sidot describes. (To witness): Do you think that Prof. Dewar got by his experiment the result which Sidot describes? Yes; I think he got a result which is to be obtained by Sidot's first process, if you like to follow it out in that way, but it is by no means the only result that can be obtained by Sidot's process. Sidot prescribes the carbonisation of the wood or other material in the vapour of disulphide of carbon. Prof. Dewar carbonised these things first, and then submitted them to Sidot's process afterwards. Moreover, Sidot prescribes about an hour as the duration of the operation; Prof. Dewar gave it three. Then Sidot prescribes, as an alternative to disulphide of carbon, spirit of wood, carburetted hydrogen, &c.

Mr. MOULTON: I wish the professor would correct that. I think he is looking at the translation. If he will look at the original he will see that it was hydro-carbon.

WITNESS: Spirit of wood, carbides of hydrogen, that is the literal translation. It is in my translation carburetted hydrogen.

Mr. JUSTICE BUTT: I am quite out of my depth.

Mr. MACROBY: Will you explain to my lord whether there is any difference between carburetted hydrogen and the carbides of hydrogen, and if so in what respect?—I think the French phrase has a wider meaning than this English translation before me.

Mr. JUSTICE BUTT: Let us deal with the English. Is there a distinction between the carbides of hydrogen and carburetted hydrogen?—Yes. A chemist would understand them with a slightly different meaning.

Mr. MACROBY: He prescribes a preparation of spirit of wood, and the carbides of hydrogen. Anything else?—That is all he prescribes; he merely puts "&c."

Did Prof. Dewar try that or not? Prof. Dewar did not try, or at least did not exhibit any result of an experiment with disulphide of carbon; neither did he exhibit any result with spirit of wood.

Did he not exhibit the result of treatment with the vapour of disulphide of carbon? No.

Mr. CHARLES: It was benzol.

WITNESS: Neither did he exhibit a result with carburetted hydrogen gas, which is one of the carbides of hydrogen. The only result that he exhibited or obtained was by the vapour of benzol, or benzine as it is sometimes termed. Now what I have to remark upon that is, that benzol consists almost entirely of pure carbon; it contains 92·3 per cent. of carbon while spirit of wood contains only 37·5 per cent. Disulphide of carbon contains only 15·8 per cent. of carbon.

Mr. JUSTICE BUTT: So that you say treatment by benzol is not analogous to any of the treatments Sidot recommends?—No, I cannot go so far, because benzol would be included in the carbides of hydrogen, but not in this English translation, carburetted hydrogen.

Never mind about the English translation. Sidot's paper is in French. If it is within what Sidot describes in French, it is within Sidot's description. What is your objection to the treatment by benzol?—The treatment by benzol would have a tendency to deposit a much larger quantity of carbon upon the carbonised or carbonising material than any of the other substances prescribed by Sidot. The effect of this would be the matting together of the fibres produced in the operation or submitted to the operation, and the making of those fibres lumpy, as is perhaps the most proper term. This result would be heightened by continuing the process for three hours instead of one hour.

Have you tried the process yourself?—Yes.

Mr. MACROBY: I understand that Prof. Dewar, in the first place, selected an exceedingly rich carbon?—Yes, I have no doubt with the best intention. He said he would give it a good chance.

Mr. JUSTICE BUTT: He gave it too good a chance.

Mr. MACROBY: Exactly. As regards length of time he gave it a still better chance to produce nice large nodules of carbon?—Yes.

I suppose it is somewhat analogous to the electrotyping process we heard of yesterday?—Yes; there is some analogy. The longer you carry it on the thicker the material gets, and it may get more irregular and lumpy.

And you may cause a failure by over-pressing it?—Certainly.

Will you be kind enough to tell his lordship what experiments you made in company with Prof. Donkin, following the directions in Sidot's paper?—I took strips of wood, linen, thread, hemp fibres, and strips of paper. I placed these in a porcelain tube as directed by Sidot, and then put this tube in a furnace in which it could gradually be heated to redness. I began by passing the vapour of disulphide of carbon through the tube until all the air was expelled. I then gradually raised the temperature of the tube to redness, and kept it at that temperature for an hour, the vapour of disulphide of carbon passing through the tube all the time. These are precisely the directions given by Sidot. Then the tube was allowed to cool somewhat and the materials were removed. The specimen I hold in my hand is one of the splints

of wood. The splint of wood has produced a literally regular strip of carbon, which is highly elastic, and which corresponds with what Sidot says you get by the process.

You say this is the result of Sidot's process?—That is the result which I obtained from Sidot's process.

Mr. ASTON: Of Sidot No. 1?—Of Sidot No. 1.

Mr. MACRORY: It may or may not be important, but what wood did you select?—It was boxwood. Then this is the result with the hemp fibres (exhibiting), this with linen thread, and this with the strips of paper. The chief difference in the results is seen in the strips of paper. The strips of paper produce a carbon which is very flexible and can be bent into any shape. The others are highly elastic; they can be bent, but if you bent them very short they would be broken.

The last is by far the most flexible?—The most flexible, but the least elastic; it is almost without elasticity.

The others that are not so flexible are highly elastic?—Yes.

Would you call those carbon filaments?—I think they are all entitled to be called carbon filaments.

Mr. JUSTICE BUTT: That is not precisely the same thing. Would you call them carbon filaments?—Yes. I do not want to define filaments, but I should call those filaments.

Mr. MACRORY: These are continuous filaments?—They are all continuous, and some similar ones have been made into lamps.

Supposing you took one of these carbon filaments and put it into the lamp which has been called Swan's lamp, what would be the result, in your judgment?—The lamp would be that you would have a lamp of greater commercial efficiency than Mr. Swan's lamp.

Do you see any difference between such a lamp and that described and claimed by Mr. Edison?—No. If the filament had the shape given to it that Mr. Edison gives to his, then they would be, in my opinion, identical.

Of course it would be quite easy to make those filaments in the shape of a spiral.—I have made no attempt at shaping them in these experiments, but I could easily have made them in any shape I pleased by shaping the materials. If those fibres were coiled into a spiral and put into Mr. Swan's lamp you would have substantially an Edison lamp according to his patent, 4,576.

Where those filaments put into the shape in which we see them prior to or after carbonisation?—They were put into the shape that they assumed when they were either coiled round my hand in the case of the fibres and threads, or cut from the wood and paper in the others.

Mr. JUSTICE BUTT: That does not quite answer the question. Were they put into the shape that they are in now?

(To be continued.)

THE ELECTRICAL RESOURCES OF THE ROYAL NAVY.

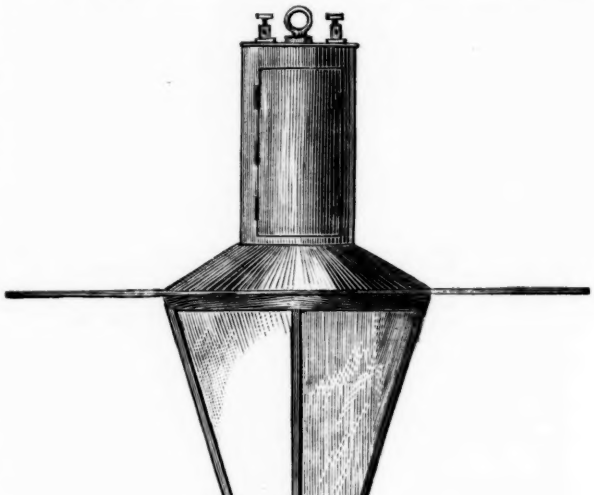
[FROM OUR PORTSMOUTH CORRESPONDENT.]

THE five hundred representatives of "Greater Britain" who paid a visit to Portsmouth on Friday last, must have been struck with the vast utility of electrical science in connection with vessels of war of every description. In their interesting tour round the dockyard the Colonials boarded almost every ship of importance that happened to be in dock, and consequently were enabled to inspect electrical apparatus as applied to the requirements of modern men-o'-war on a very extensive scale. So thoroughly impressed with the necessity of lighting every large vessel by electricity has the Admiralty been of late, that with one or two exceptions all the vessels visited by the Colonials were provided with incandescent electric lamps for internal lighting purposes, and arc search lights for the sterner requirements of war. The extreme safety of the electric light system was well appreciated by the visitors, while the complete manner in which the ships have been fitted called forth considerable admiration. In some of the newer types of warships the interior of the vessel must, but for the kindly intervention of electricity either be given over wholly to darkness, or be imperfectly illumined by means of oil lamps or candles. As it was, the visitors were enabled to view with ease every nook and corner of the ships. On board the *Imperieuse*, which is the only large belted cruiser of her particular class which we have in the Navy, 350 incandescent lamps were burning, enabling the visitors to make their way to the innermost recesses of the vessel and inspect the complete arrangements for the firing of her 18 torpedoes, a work which is performed by the aid of electricity. The *Collingwood*—renowned as the scene of the late gun explosion—was illumined by means of 400 lamps, and here the sight-seers were shown the three dynamos generating the electricity and the other apparatus connected with the electric light which, with the torpedo store, occasioned as much interest as her heavy guns and ponderous armament. On board the *Edinburgh* turret ship in course of fitting out, there are 395 incandescent lamps, besides, as in the other cases, two search lights of great penetrating powers. In respect of electricity, it was seen that smaller vessels have not been neglected, and a visit to the *Surprise* and *Alacrity* showed that their apparatus was of the most complete description. The submarine and torpedo operations in Stokes Bay during the afternoon served to illustrate the application of electricity to strictly warlike purposes, and the various experiments which were effected caused a good deal of astonishment.

ELECTRIC LIGHTING OF STEEL WORKS AT ELSWICK.

THE Gülcher Electric Light Company, Limited, of Battersea Foundry, London, have recently completed an important installation at the new steel works of Sir W. G. Armstrong, Mitchell & Co., Elswick, Newcastle-on-Tyne. We think an account of this will be useful, as the work done in this case is the same as would be required for any steel works or rolling mills.

The Elswick Steel Works consist of two long and lofty shops built side by side (but at different levels) on the slope of the Tyne. The roofs are supported on lattice girders held up by parallel rows of cast iron columns side by side, on which are other columns carrying massive girders along which travelling cranes are constantly moving. There is scarcely any wood used in the construction, and consequently the electric light wires have nearly always to be carried over iron. More than usual care in the insulation of the cables is therefore required, and it is absolutely necessary to use a low tension system. Moreover, the rough nature of much of the work carried on, such as moving heavy castings, makes an occasional injury to one of the electric light mains not a very infrequent occurrence, and if the lamps were not perfectly independent much



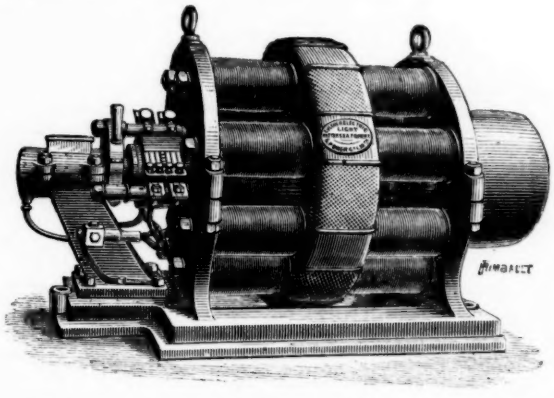
trouble would result, and even danger to life, on a high tension system. Cables, well insulated in the ordinary manner, are used, and in every case these are carried on stoneware insulators held by set screws screwed into the iron girders, or more often into a piece of an iron bar previously drilled and tapped and cut to a suitable length for taking several wires one above the other.

This is fixed by a screw at the top and bottom to the side of a girder or column.

Wherever possible the arc lamps have been suspended from the centre of the roof by a pulley fixed to a tie rod, but where the travelling cranes do not permit of this being done the lamps have been hung under the girders along which the travellers move. To raise and lower the lamps iron pulleys have been screwed to the girders, and the rope passing over them, used for suspending the lamps, is held by a rope-gripper, specially constructed, that has a kind of movable jaw, worked by a thumb screw that either grips the rope or allows it to run through, as may be desired. The switch and regulating resistance coil of German silver wire belonging to each lamp are both fixed on the same slate bed, and this is screwed at a convenient height to the side of the iron column nearest the lamp. The wires brought down to them are protected from injury by an iron casing. The arc lamps used are all of the 3,000 C.P. factory type shown in the accompanying illustration.

Pending the completion of the buildings only 22 of these have been fixed at present, but wherever possible provision has been made for 50. There are two lamps in parallel on each circuit, the wire used being 7 15. The current through each lamp is 15 ampères.

For generating the current two No. 6 Gülcher dynamos of the latest type (see illustration) have been fixed, though only one is used at present. These are driven by an engine manufactured by Hicks, Hargreaves & Co., of Bolton, which will be used during the day for pumping. Steam is obtained from a range of boilers just outside the engine house. The dynamos are compounded to give a constant E.M.F. at their terminals of 70 volts at 460 revolutions per minute, and they have an output of 30,000 watts. They have two pairs of brushes only, which run without sparking or heating on the commutator.



Each machine is, therefore, capable of driving 25 of the 3,000 C.P. lamps, or an equivalent number of incandescent lamps, or some of each may be employed as in this instance, where the manager's private office, the pattern makers' and the fitters' shops are fitted with 20 C.P. Swan incandescent lamps.

The terminals of the two machines are not connected directly to the leads going to the lamps, but joined to a switch table of very substantial construction which stands in the engine house. This is so arranged that any of the circuits may be switched on to either of the dynamos. The positive wire of each of the circuits is brought to one of 28 separate switches which are arranged in four circles of seven each on the top of the table, each of these four circles are in turn connected to one of two large and heavy switch handles, by the shifting of which to the right or left the positive terminal of one or other of the machines is placed in connection with the lamp mains.

The negative terminal of each machine is connected to a heavy gun metal bar at the back of the switch board. Parallel to this is a row of terminal screws, into one of which each of the negative lamp mains is inserted.

A piece of tin wire of a suitable size to fuse, if there should be any great excess of current, forms the connections between each lead and the negative bar. There is also a fuse in the switch placed near each of the lamps.

Each lamp has, therefore, a switch and fuse of its own, and each pair of lamps a switch and fuse in the engine shed. The position of the lamps is often temporarily altered, and a supply of thin flexible cable is kept, so that the lamps can be shifted without moving the switches or rheostats.

In addition to the arc lamps provision has been made for about 40 incandescent lamps in the pattern makers' shop, the fitters' shop, and the manager's private office. Each lamp has a separate fusible wire, and in the private office a separate switch also.

This installation supplies an instance of the electric light being chosen by a company making their own gas on the premises. The work is carried on day and night, and the improvement in the light is much appreciated by the night shift.

STEPHENS' INDIVIDUAL TELEPHONE CALL APPARATUS.

THE object of this apparatus is to enable an exchange station into which a telephone line having a number of subscribers on it, runs, to cut off the whole of the latter, with the exception of any one or two to whom it is desired to give the control of the line. By this arrangement the subscribers who are cut off cannot break in and interrupt, or overhear, the conversation of the particular subscribers in question, nor can they call the exchange until the latter restores the line to its normal condition.

The general principle of the invention, which is exceedingly ingenious and effective, and also, we believe, thoroughly reliable, is shown by the figs.

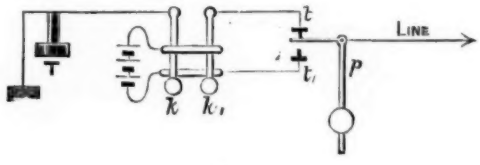


FIG. 1.

Fig. 1 represents the arrangement at the exchange station. The pendulum, p, it will be seen, normally keeps the line on the earth terminal, t. At each semi-oscillation p puts the line on to contact t_1, that is to say, on to the negative pole of the battery, the positive pole of the latter being to earth through the bridge of the keys, k, k_1; thus if the pendulum be swinging, the line will be alternately connected to the negative pole of the battery and be put to earth. Let it be remembered, then, that intermittent *negative* currents will be sent to line by the action of the pendulum. At a subscriber's station, which is shown by fig. 2, the Up

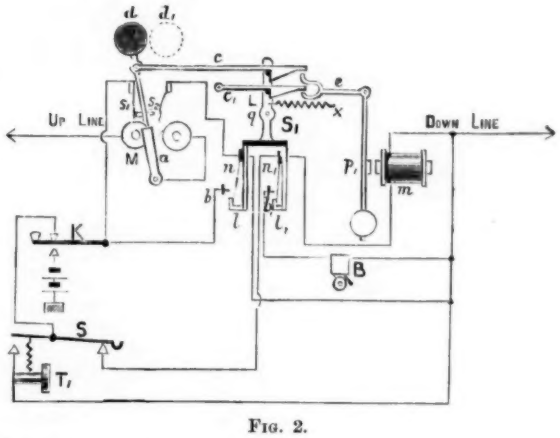


FIG. 2.

line (the line from the exchange station) is attached to one terminal of an electro-magnet, M. This electro-magnet has a polarised armature, a, playing between its poles; the winding of the electro-magnet is such that if a *negative* current be sent from the exchange station then the armature will be moved over (or will remain over) in the position shown in the fig.

The other terminal of the electro-magnet is connected to the armature, a, as shown.

A contact piece fixed to the upper part of the armature rests either against contact spring, s_1 (as shown in the fig.), or against contact spring, s_2, the arrangement being such that the armature in moving from one position to the other makes contact with one spring before it breaks with the other. Spring s_1, it will be seen, is connected with the lever of the ringing key, K, of a telephone apparatus, T_1, the latter including the receiver, microphone, induction coil, &c.

S_1 is a double switch consisting of two levers, l, l_1, insulated from each other but moving together, being both attached to the common lever, L, which is axled at q. This lever normally tends to be drawn to the right by a light spring, x, but it remains in the position shown in the fig., when two pins at its upper end are hitched under the hooks, c, c_1. One of these hooks, c, is connected to the prolongation of the armature, a, of the electro-magnet, M.

The pendulum, p_1, which is actuated by impulses sent through the electro-magnet, m, has an arm, e, at its upper end, the prolongations of this arm when the pendulum comes into full swing strike up the hooks, c, c_1, and releases the lever, L (should this lever be hitched by one or both of the hooks), and allows it to be drawn over by the spring, x.

The levers, l, l_1, have insulated contact springs, n, n_1, fixed to them; the lower ends of these springs normally make contact with the hooked ends of the levers, l, l_1, as shown. When, however, the hooks, c, c_1, release the lever, L, so that the latter is pulled over by the spring, x, then the levers, l, l_1, move to the left, and the springs, n, n_1, come against the contact points, b, b_1, and at the same time move out of contact with the hooked portions of l, l_1, so that the circuits which were complete between n and l, and between n_1 and l_1, are now complete between n and b, and between n_1 and b_1.

The action of the whole apparatus is as follows:—Supposing that one of the subscribers, say the one at the station represented by fig. 2, on the line wishes to be put through to, say, any other subscriber on the same line, he depresses his key, K, and thus, by means of the battery connected to the lower contact stop of the key, transmits a current, which current passes by spring s_1, through armature a and magnet M to the Up line; this current passes through M in the direction which tends to press the armature, a, against the spring, s_1. If the station in question is the one next to the exchange (fig. 1), the latter receives the call on his telephonic apparatus, T; but if there are other stations between them, then assuming that fig 2 now represents one of these stations, the current will come in from Down line, will pass through electro-magnet, m (there being no other path open to it); from thence it will pass *viâ* lever l_1 and spring n_1 to the front contact of telephone switch, S (which is, of course, held down by the telephone receiver hung on it), and then passes through key K, out through s_1, a, and the magnet, M, to line. Thus it will be seen that the current in passing through the intermediate stations can do nothing but impart a slight impulse to the pendulums. As soon as the exchange receives the call he communicates with the subscriber calling by means of his telephone; the subscriber then notifies to the exchange station which subscriber he wishes to communicate with, and having done so, he replaces his telephone on the switch hook. The exchange then sets the bob of his pendulum at the mark corresponding to the rate of vibration of the pendulum of the subscriber with whom it is required to communicate. This being done the exchange sets its pendulum vibrating, thus causing a succession of negative currents to be sent through all the electro-magnets of the subscribers. The pendulum of the subscriber to be called commences to vibrate in unison with the impulses, and when the amplitude of its swing becomes great enough the arm, e, attached to it strikes up the hooks, c, c_1, and allows the lever, L, to be pulled over to the right by the spring, x, the levers, l, l_1, consequently moving over to the left. Springs, n and n_1, are now disconnected from l and l_1, and are in contact with b and b_1. As soon as this takes place the currents which are passing no longer pass through the magnet, m, but are shunted instead through the bell, B, the latter consequently rings and shows the subscriber that he is being called. The exchange having allowed a sufficient interval to elapse for the pendulum, p_1, to have done its work of striking up the lever hooks, c, c_1, places his telephone in circuit and communicates with the subscriber; the latter having acknowledged the call hangs his telephone back on the switch hook. The exchange now actuates the pendulum of the first subscriber, and having caused it to vibrate sufficiently long to release the switch, S_1, he now for the first time depresses key, k (fig. 1), and sends a positive current to line; this causes the armature, a, of the electro-magnet, M, at each of the subscribers offices to move over to the right so that the disc, d, comes to the position shown by the dotted lines d_1, and the contact is changed from spring s_1 to spring s_2. It will then be seen that the telephone instrument, K, S, T_1, at each office is cut out of circuit and cannot interfere in any way; communication, however, is complete from the Up to the Down line through the medium of spring s_2, n, and l, for although the hook, c, has been pushed forward yet lever L is still held by the hook c_1. At the offices of the two subscribers, however, where the hooks, c, c_1, have both been struck up by the action of each pendulum, p_1, although communication has been cut off through the spring, s_1, yet communication has been restored through spring, s_2, n, b, the key, k, the lever, s, n_1, b, the bell, B, and the Down line. The current sent from the exchange consequently now rings the bell, B, at the two subscribers' offices, and as the discs have been moved over to the position, d_1, those subscribers know that they are in communication with each other and that all the other subscribers are locked out, they therefore take their telephones off their switch hooks and communicate with each other. The subscribers at the other stations seing their discs over know that the line is engaged.

As soon as the conversation is finished either of the two subscribers "rings off," and the exchange then sends a current by depressing key k_1, this causes the armature, a, at each subscriber's office to be moved over again to the position shown in fig. 2, when the disc, of course, indicates that the line is once more clear.

The movement of the armature, a, at the offices which have been conversing pulls over the lever, L, by means of the hook, c, since the latter, when the armature, a, made its right-hand movement, became engaged over the pin at the end of lever L. Thus all the stations are restored to their normal condition.

It may be mentioned that by placing the pendulum magnet, M, in circuit with the connection leading from lever-arm, l, instead of in the position shown in fig. 2, then the line may be locked first and afterwards the exceptions made.

We understand that Mr. Stephens' apparatus is in successful practical operation.

LEGAL.

Field v. Bennett.—On Monday this action, brought by Mr. Cyrus W. Field against Mr. James Gordon Bennett, of the *New York Herald*, in which judgment had been allowed to go by default, came before the Middlesex Sheriff's Court, in Red Lion Square, in order that damages might be assessed for two libels on the plaintiff published in the defendant's newspaper. The case was heard before Mr. Under-Sheriff Burchell and a special jury. There was no appearance on behalf of the defendant.

Mr. Pollard, counsel for the plaintiff, said his client's name was well-known on both sides of the Atlantic as the pioneer of Atlantic telegraphy. To his enterprise the public owed the construction of a cable which was carried out at a vast expenditure of his own money and that of his friends. The speculation ultimately resulted in the formation of the Anglo-American Cable Company, of which Mr. Cyrus Field had all along been a director, and had represented its interests solely and successfully in New York. Mr. Field was proprietor of the *New York Mail and Express*, and was one of the members of the American Associated Press, which was a body consisting of the seven leading newspaper proprietors in the United States. The defendant was also a member of that Association, but later on he was instrumental in bringing about the laying of the Mackay-Bennett cable in opposition to those already existing. This latter company had offices in Cornhill for the collection and transmission of news, and on the 4th of February, 1885, the first libel complained of was sent through that medium as follows:—"London, Feb. 4, 1885.—Mr. William Abbott, broker and operator, Tokenhouse Yard, supported by many stockholders of the Anglo-American Cable Company announces that at the Friday meeting of the directors of the company he will introduce a resolution to expel Mr. Cyrus W

Field from the directorship, on the ground that he is unworthy of any position of confidence and trust." This telegram appeared in the *New York Herald* of the 5th of February. There never was such a resolution proposed, and there never was any intention to propose it. It was, therefore, not only libellous, but utterly untrue in fact. There was a second libel sent on the 12th of the same month, consisting of an extract from *Truth*, aggravated by a leading article calling attention to it. For these libels the plaintiff now claimed £10,000 damages. Subsequently Mr. Abbott apologised handsomely, and *Truth* also. The *Financial News*, which had copied the telegram, likewise apologised, and the fact of these apologies having appeared was telegraphed by the American Associated Press, and was inserted in other American papers, but not in the *New York Herald*, showing that the defendant, relying on his own wealth, was regardless of the injury he had done to a fellow journalist. This was clearly a case in which nothing except exemplary damages would bring Mr. Bennett to a sense of his wrong-doing, or compensate Mr. Field for the injury he had sustained. Mr. Cyrus W. Field, the plaintiff, was called, and bore out the opening statement of his counsel. He stated that he was a special partner in the firm of Field, Lindley, and Co., the largest shippers of grain from America to Europe, and having agencies in London, Liverpool, Glasgow, Bristol, and other British and Continental ports. He was besides director of ten large corporations, seven of which were in America and three in London. For some years past he had spent more than half his time in England, where he had a great many friends. There was not a shadow of foundation for either of the libels, and they were calculated to do him immense injury. He had not yet taken action in America, but intended to do so by-and-by. The jury found a verdict for the plaintiff—damages, £5,000.

NOTES.

The Electric Light in a Church.—A new church, opened by the Bishop of Durham at the colliery village of New Herringbon, has the distinction of being the first place of worship in the North of England to be lighted by electricity.

The Electric Lighting of Covent Garden Theatre.—We understand that we were in error last week in supposing that Mr. Thomas had ignored the claims of the Jablochkoff Company for this work, as he offered them the contract upon the same terms as Messrs. Paterson and Cooper have accepted. The offer was declined by the Jablochkoff Company, which, however, is still in favour with Mr. Thomas, as he has given the company the order for a complete installation of incandescent lights for his new premises in the Strand.

American Telegraph Arrangements.—It is stated that the Canadian Pacific Telegraph Company has made a working arrangement with the Commercial Cable Company for an exchange of business over their respective lines.

The Telephone in Austria.—The Vienna *Electro-Techniker* states that the Consolidated Telephone Construction and Maintenance Company and the Telephone Company of Austria have met with a severe rebuff at the courts in Austria. The first-named company had lodged an action for annulment of the patent of Professor Alexander Graham Bell, the well-known inventor of the telephone, in order to protect its Austrian establishment. This action, like many others, has now been dismissed with costs by the Austrian judicial authorities. As in England, the Bell patent remains, consequently, in force in the dominions of the Austrian monarchy, and the Telephone Company of Austria, being infringers of that patent, will have to reckon with the patent owners.

Long-Distance Telephony in Austria.—The *Standard's* Vienna correspondent telegraphed on Monday :—"The telephone between Vienna and Brünn, a distance of 100 miles, commenced working to-day, and is a complete success. The system employed is that of Ryssel-berghe, which allows of the use of ordinary telegraph wire. Preparations are already being made for the establishment of regular telephonic communication between Vienna and Pesth, a distance between two and three times as great as between Vienna and Brünn."

The United Telephone Company.—The *Financial News* remarks that the United Telephone Company prospers in despite of a management which can hardly be called active, and which might with advantage be made a good deal more energetic. For example, if we are well informed, the official report of the last meeting has not yet reached the shareholders in the company, and yet at that meeting there were very important proposals brought forward, such as the separation of the shares of the subsidiary companies from the parent undertaking and their distribution among the proprietors in the form of trust certificates. This proposal cannot be allowed to sleep, and it would be far better for the directors to say, and say frankly, what they think of it rather than allow things to drift along. The telephone is only in its infancy here in England. Elsewhere it has been much more developed, and if Mr. Brand and his co-directors are to make the most possible for their shareholders—and this "most" is a great deal—they must wake up and drive the great business which is ready to their hands. They are doing pretty well now ; but they might do a great deal better.

The French Atlantic Cable Company.—In regard to the disputes which have arisen over the conduct of the business of the French Cable Company, the following translation of a letter which appeared in *Le Matin* of July 22nd, may not be without interest :—"To the Editor of *Le Matin*.—Sir,—In to-day's issue of your paper you publish, under the heading 'Compagnie Française du Télégraphe de Paris à New York,' the judgment pronounced by the Tribunal of Commerce of the Seine, at the request of a large number of shareholders dissatisfied with the way the company's affairs are managed by the present board of directors. The summary of the judgment published by you omits one of the clauses, although it is of the greatest interest to the shareholders. I refer to the one concerning the dismissal of the present directors. Allow me to complete your report. You are aware that at the general meeting, held June 23rd, the dissenting shareholders requested the chairman, Mr. Pouyer-Quertier, to put to the meeting a motion for the 'immediate dismissal' of the board, and that he refused to submit this motion to the shareholders, pretending 'that it was not entered on the order of the day.' It is in order to overcome this refusal on the part of the president, a refusal that a simple feeling of dignity ought to have prompted him not to inflict on them, that these shareholders have applied to the tribunal requesting it to declare that at the next general meeting the board of directors should be obliged to place the motion for their own dismissal on the order of the day. On this point the tribunal has ruled as follows :—'Whereas, although the directors have the right to arrange the order of the day of the general meeting, the general meeting of the shareholders has the right to maintain or dismiss its representatives on the board, nor is it necessary that this motion should be entered on the order of the day ; there is, therefore, no need to order a special entry on this subject to be made on the order of the day of any general meeting.' As you see, this clause is quite clear. But Mr. Pouyer-Quertier and his colleagues need not doubt. The dissatisfied shareholders will not fail to enforce, at the next general meeting in October, the right that the judgment of the tribunal of commerce has once more acknowledged to be theirs.—I am, sir, yours obediently, ONE OF THE NUMEROUS DISSATISFIED SHAREHOLDERS."

The West African Cables.—At an entertainment given at Sierra Leone on July 13th, in celebration of the opening of the African Direct Telegraph Company's station at that place, a loyal address to Her Majesty was adopted by the meeting, and transmitted by telegraph to the Secretary for the Colonies. In the name of the inhabitants of Sierra Leone, the address expressed profound loyalty and gratitude to the Queen, and hoped that the cable might contribute to an increased interest being taken in the development of the

resources of the African Continent and a larger exertion of the benign influence of Her Majesty's Government on its destiny. On July 24th Lord Granville telegraphed as follows to the Governor of Sierra Leone :—"Referring to your telegram of the 13th of July, Her Majesty commands me to convey her cordial thanks to you and her loyal subjects for their address."

We learn that the India Rubber, Gutta Percha, and Telegraph Works Company's ships *Silvertown* and *Dacia* have laid the shore ends at Grand Bassam for the Grand Bassam-Accra section. It is expected that by this time that section will have been completed, for the shore ends were laid on the 12th inst. News from this part of the coast comes to hand but slowly, depending on the not very perfect postal arrangements, for the African Direct Telegraph Company have not yet completed their section between Sierra Leone and Accra. It is, however, expected that this cable will be very shortly laid. We are glad to hear that the Silvertown Company's engineer reports all hands to have enjoyed excellent health, not a single case of fever having occurred.

Electrical Exhibits at the Leicester Exhibition.—On Thursday last the medals and certificates awarded to the successful exhibitors at the Leicester Exhibition were presented at the Royal Institution. Messrs. Woodhouse and Rawson obtained a medal for their electrical exhibit, and a certificate for their Cunynghame, Woodhouse and Rawson automatic cut-outs.

The Edison Company and Users of Incandescent Lamps.—Messrs. Muir and Mavor, of Glasgow, have forwarded us the following reply from the Edison and Swan Company to their letter which we published in the REVIEW two or three weeks ago :—"I beg to acknowledge the receipt of your letter of the 9th inst., and to express my regret that acting under misapprehension, I should have sent to Mr. Holden the letter of 1st inst. from which you quote. I have no hesitation in saying that I very greatly regret that I should have written to Mr. Holden unnecessarily. I do not share your opinion that my doing so can have any prejudicial effect on your interests ; but in order to put the matter quite right, I write to Mr. Holden by this post expressing my regret that we should have troubled him in the matter. I hardly know what satisfaction you will receive from sending your letters to the electrical papers, but that is manifestly a matter for you, although it is customary when a frank expression of regret is made to accept it."

Notice of Removal.—Messrs. Swete and Main have moved their offices from Battersea to 11, Queen Victoria Street, E.C., where they will continue their business as electrical engineers and electricians.

A Wire Tester.—Messrs. W. H. Bailey and Co., of the Albion Works, Salford, the *Mechanical World* states, have just constructed, for the use of the South Australian Government Telegraph Department, a wire tester on an improved principle, specially designed by Mr. W. H. Bailey. The tensile strength of the wire is tested in an ingenious manner by means of a column of mercury, and when the wire breaks, a back pressure valve prevents the return of the mercury, so that the breaking strength of the wire is thus exactly indicated. There is also a diagram attachment used with the machine which indicates on metallic paper the elongation of the wire before the maximum breaking strain of the wire is reached. The arrangements of the machine are so simple that levers and springs are entirely dispensed with.

Changing Chairs.—Prof. H. S. Carhart, greatly to the regret of his University, where he has won the highest regard by his scholarly attainments and professional enthusiasm, has accepted the chair of physics at the State University at Ann Arbor, Michigan. The professor's writings on electrical subjects are well known to readers of the REVIEW.

Thunderstorms.—Last week a series of thunderstorms occurred in East Kent, and various incidents are reported. Farm buildings at Herne, near Canterbury, were set on fire by the lightning, and damage done to the amount of about £250. At Moxton the wife of a retired Dover tradesman, while standing at the door of her house, was rendered insensible by a blinding flash, and continued so for several hours. A man, named Kettle, who took refuge under the verandah of the Maidstone and Ashford Railway Station at the latter town, had a peculiar experience. He was wearing a steel pin in his cravat, and fancied that a flash of lightning played about it and that he smelt sulphur. He, however, thought nothing of the matter until he got home when the discovery was made that the bright steel had been turned black. The cravat, a woollen one, was singed where touched by the pin.

During the thunderstorm on Saturday last one of the poles on a private wire at Ovenden, Yorkshire, the property of Messrs. J. Crossley, Sons & Co., of Halifax. was completely destroyed by the lightning. The top part of the pole was shattered altogether, small pieces of the timber flying in all directions, while the lower portion was split in two. The pole, it need scarcely be added, was not protected by an earth wire.

Electrical Transmission of Power.—The correspondent of the *Times* at Paris has made the following communication to his journal :—"During the last ten years M. Marcel Deprez has been engaged in experiments connected with the transmission of force by means of electricity. The Rothschilds some time since provided him with an unlimited credit to prosecute his researches at Creil, under the inspection of a commission of 38 men of science. On Friday the commission met to hear a report on the results at present obtained, drawn up at their request by M. Maurice Lévy. This report was unanimously approved. It appears from it that we can now, with only one generator and only one receptor, transport to a distance of about 35 miles a force capable of being used for industrial purposes of 52 horse-power, with a yield of 45 per cent., without exceeding a current of 10 ampères. When the amount of force absorbed by the apparatus used to facilitate the recent experiment, but not required in the applications to industrial purposes, is added, the yield will be nearly 50 per cent. The commission certifies that the machines now work regularly and continuously. The *maximum* electromotive force is 6,290 volts. Before the construction of the Marcel Deprez apparatus the *maximum* force did not exceed 2,000 volts. The report states that this high tension does not give rise to any danger, and that no accident has occurred during the past six months. The commission is of opinion that the transmitting wire may be left uncovered on poles provided it be placed beyond the reach of the hand. It estimates at nearly £5,000 the probable cost of the transmission of 50 horse-power round a circular line of about 70 miles. This price would, however, be much diminished if the machines were frequently constructed. The commission, in the name of science and industry, warmly congratulated M. Deprez on the admirable results which he had obtained, and expressed thanks to the Rothschilds for the generous aid extended to the undertaking."

Another Cable in the Atlantic.—The Commercial Cable Company, if an announcement in the *Financial News* is correct, is about to lay a third cable, with the object of doing business at a maximum rate of 1s. per word.

Electricity in the Royal Navy.—In accordance with instructions from the Admiralty, a commencement has been made in the work of installing the electric light for internal purposes on board the torpedo school-ship *Defiance* at Devonport. Other necessary electrical apparatus has also been supplied to this vessel, with the view of obviating the manifest disadvantage of officers from Devonport having to be sent to Portsmouth to gain instruction in torpedo work.

Electro-Motors for Railways.—In a not very optimistic article upon this subject in last week's *Industries*, the writer says: "Another very necessary improvement is some device by which the speed and power of electro-motors can be varied at will, without wasting power by the introduction of artificial resistances. Such a device would be equivalent to the expansion gear in a steam engine, and would be necessary, not only for economic reasons, but also for the purpose of having the speed of the electric train under as perfect control as that of an ordinary train drawn by a steam locomotive." Evidently the writer of these remarks has forgotten the fact that Mr. Reckenzaun has invented such a device as he prescribes, and has applied it to his well-known tram-car system.

Directors and Proxies.—Shareholders have latterly been in the habit of protesting strongly against the almost universal practice amongst directors of sending out at the expense of the company stamped proxies bearing the name of the chairman or some one or more of the members of the board. A recent judgment of Mr. Justice Kay has held that the cost of such procedure should be charged to the directors' private purses; and Mr. John Pender, at the meeting of the Direct United States Cable Company last week, announced that the directors of that company had undertaken the expense of the proxies this year. Yesterday Lord Monck stated that the directors of the Anglo-American Telegraph Company had adopted the same course. One shareholder thereupon suggested that they should go a step further, and in future refrain altogether from issuing proxies, but he received very little support in his contention that the proxy system was entirely wrong.

Incandescent Lamp Patents.—The Edison-Swan Company has commenced legal proceedings by serving a writ upon the Jablochkoff and General Electricity Company for infringement of patents by using lamps at the Albert Palace which are not of the Edison-Swan manufacture. We are informed that these lamps were purchased from the Anglo-American Brush Corporation, and that steps are being taken to enable the Corporation to defend the action as third parties. Mr. William Holland, of the Albert Palace, has also been served with a writ for the same alleged infringement. We may add that the Anglo-American Brush Electric Light Corporation has commenced a suit against the Edison and Swan Company for injunction and damages for infringement of the Lane-Fox patents for incandescence lamps. It seems likely that the Anglo-American Brush Corporation will have an anxious time of it shortly. There is, we believe, the case of the Corporation *v.* Crompton; that of Crompton *v.* the Corporation; and, thirdly, as appears from the above information, the Corporation must figure both as defendant and plaintiff in threatened proceedings on the recently decided incandescent lamp patent case. What a harvest for the legal fraternity!

Electromotive Force of Batteries.—Mr. Sydney F. Walker suggests in our correspondence columns that the standard E.M.F. of batteries should be that measured on open circuit. When the E.M.F. of various cells are compared the measurements are always so made, but this free potential must not be taken as the E.M.F. of the battery when connected up and doing work. As an instance, let us suppose that a battery indicates 50 volts on open circuit. If now we set it in action with an external resistance equal to its own internal resistance, the difference of potential at the terminals, or the working E.M.F., will drop to 25 volts. It is then this last figure which, multiplied by the current, gives us the electrical energy developed in the external circuit. Unfortunately it often happens that the free potential of the battery is used for making these calculations instead of the difference of potential at the battery terminals *when in operation*; a fictitious value is thus given to the battery which leads only to disappointment in actual practice.

The Maquay Battery.—We imagine, from the description of the oxidisable plate of this battery—an alloy—that local action will form no unimportant part in its working, notwithstanding the supposed impregnation of the metal with mercury. We have always been under the impression that local action was a thing to be avoided if possible, or at least reduced to a minimum.

The "Great Eastern."—Another attempt is being made to finance the *Great Eastern*. A company has been formed called the Great Eastern Steamship (Exhibition and Entertainment) Company, Limited. Its proposed capital is £100,000 in £1 shares, and £60,000 is to be issued at once. The ship "is now being exhibited by Messrs. Lewis & Co. in the river Mersey with great success." The vessel is to be bought by the company as she lies for £50,000, partly in cash, partly in fully-paid shares. The *Great Eastern*, as we have already informed our readers, is lighted by the Jablochkoff system.

The Marchant Engine.—This engine was exhibited at the Inventions Exhibition last year, but unfortunately owing to grave defects in the boiler supplying the steam, very few opportunities were given to see the machine in operation. Since that time the boiler has been thoroughly overhauled and re-rivetted, and is now capable of rendering power in excess of all present requirements. The engine is now erected at Messrs. Fraser and Fraser's boiler manufactory, Bromley-by-Bow, London, E., where we have seen it in operation and had it explained by Mr. Marchant, the inventor, and Mr. Downie, managing director of the Marchant Engine Syndicate, who appeared to be very willing to answer every question, and stated that what they most desired was to court public inspection as to the merits of the invention. In this engine the main feature is the return to the boiler, by means of pumps and appliances, of the heat in the steam which would otherwise be wasted. If all the information given to us be correct—and we have not the slightest reason to doubt the reliability of the statements—the Marchant engine will have a future such as to revolutionise the entire applications of steam for motive power. To electric light engineers it will be the one boon long desired to enable them to compete with gas lighting on favourable terms, and a prime motor consuming under 1 lb. of coal per brake H.P. should effect such saving in running expenses as to render central stations a possibility. We shall hope to give particulars of this invention with illustrations at a future date.

A Curious Effect.—The general belief that an incandescent lamp is absolutely innocuous as regards its power of blackening ceilings, has in one case at least been proved to be not absolutely correct; we recently had shown to us a case in which one of these lamps was placed at a distance of about 18 inches from a white-washed ceiling, and directly over the lamp a circular space of about the diameter of the glass bulb had become blackened as though by the action of smoke. This result no doubt is due to the heated current of air set up by the lamp carrying with it particles of dust continually against the ceiling.

The Right Kind of Home Rule.—The Alliance and Dublin Consumers' Gas Company refused to comply with the petition of the Town Commissioners of Drumcondra for a reduction in the gas charges, whereupon the Commissioners set about taking steps for the introduction of the electric light, applying, in the first instance, to the Midland Great Western Railway Company for permission to utilise the waste water from the Royal Canal to drive the dynamos. We are not aware whether the application has been granted, nor have we heard of any further action on the part of the plucky Town Commissioners of Drumcondra. Perhaps some of our readers in Ireland can give us some information on the subject.

Appeals against Legal Decisions.—How is it that Messrs. Woodhouse and Rawson and the Edison-Swan Company respectively are so certain that the appeal in the incandescent lamp patent case will turn out as each party desires it should? Both sides have doubtless been advised by eminent counsel, but it is not a little curious that the advice should be of a diametrically opposite character.

The Edison-Swan Company's Report.—There are many interesting points in the speech which the chairman delivered to the shareholders in the above company on Tuesday last. We cannot see from whence he derives his consolation over the Victoria Station lighting, unless indeed it be due to his *indirect* connection with a certain railway; nor do we perceive the wisdom of suggesting the possibility of raising the price of lamps. We would rather urge upon the company the advisability of preparing the lamps so as to consume less electrical energy per candle-power and to be contented with allowing them a moderate lifetime. In fact let the company be prepared to supply consumers with precisely similar lamps to those hitherto manufactured by Woodhouse and Rawson, many thousands of which must by this time be near the end of their tether. As an alternative perhaps Messrs. Woodhouse and Rawson may eventually continue the manufacture of their lamps under a nominal royalty!

The Edison-Hopkinson Dynamos at the Indian and Colonial Exhibition.—The dynamos for the whole of the internal incandescent lighting have been supplied by the Edison and Swan Company, and are of the Edison-Hopkinson type, manufactured by Messrs. Mather and Platt, of Manchester. There are in all eight machines, but only six are at work, the remaining two being spare machines available for any work required of them. Four are the 10 inch long size for an output of 105 volts and 320 ampères at 750 revolutions per minute; three of these are employed for lighting "Old London," "The Hong Kong Pavilion and Tea Gardens," the Vestibule and the Indian Palace sections, while the fourth is run at a higher speed to give 130 volts, and is used for charging the E.P.S. accumulators. It was on machines of this size that the efficiency experiments were made, which we referred to and commented upon in our issue of the 12th March, 1886. We then showed that a commercial efficiency of over 93 per cent. had been attained, and the satisfactory working of the machines at the Exhibition confirms the opinion we then expressed, for good efficiency shows itself not only in economy of power but in good lasting qualities, as power wasted is always more or less destructive. Two of the remaining machines are for an output of 55 volts and 280 ampères at a speed of 850 revolutions per minute, and are employed in lighting the exhibition dining rooms. One of these is the same machine which underwent the special test of three weeks' uninterrupted run, the particulars of which we also gave in our issue of 24th January, 1885. The whole installation is a fine display of the Edison-Hopkinson dynamo which cannot but attract considerable attention.

Fires in London.—Wednesday evening was remarkable for the fires which occurred in the metropolis. At Holywell Lane, Curtain Road, Shoreditch, the upper part of an electric light warehouse was seriously damaged.

Anticosti.—We notice amongst the directorate of the company formed for buying up that earthly paradise (?) the island of Anticosti, a name well known in electrical circles. We suppose a scheme will soon be forthcoming to connect this place with Labrador by submarine cable. The first batch of colonists will probably land under the soft radiance of the electric light, and the electrical transmission of power should also be there fully developed. The engineer to the company has a name which in schemes of this nature should not be allowed to pass unnoticed. It is "Ketchum."

Submarine Cable from France to the West Indies.—Our contemporary, the *Bulletin International de l'Electricité*, calls attention to the fact that the Chamber of Deputies has refused to consider a scheme laid before them by the Minister of Posts and Telegraphs for the laying of a direct cable from France to the West India Islands, and it blames the deputies for having neglected a matter of so much importance to the country. The article in question continues:—"We are at present in the position of tributaries to foreigners for our telegraphic communication with the West Indies; a direct cable would make us independent, and, at the same time, would give us lower rates. Besides, the manufacture and laying of the new line should be absolutely reserved for French manufacturers, and we would thus have the opportunity of starting an industry which our country does not yet possess, for the preparation and employment of the necessary materials for the manufacture, the laying, and the working of submarine cables. By refusing the request of urgency proposed by the Minister of Posts and Telegraphs, our representatives seem to have ignored:—1. That they indefinitely prolong the disadvantageous position held by our merchants as compared with the situation of their foreign competitors. 2. That they refuse to create an industry of immense importance to our country, and this even at a moment when the Government is seeking every imaginable means of instilling a little life into national industries. The possible results of such conduct should not be ignored, and it is our duty to point them out to those most interested in the question." Our contemporary is, we think, rather too sanguine as to the benefits likely to accrue to French trade through any such scheme as the one under notice; and as to the commercial success of the undertaking, we do not consider that the traffic is likely to prove large enough between France and the West Indies to render the enterprise remunerative. Sentiment, with which our neighbours overflow (so long as it does not cost them anything), has exaggerated the profit France is likely to reap from this very remote addition to its national industries.

Technical Education.—The report of the results of the technological examination of the City and Guilds of London Institute shows how widely the work of the institute is diffused over the country and over the different trades in which artisans are occupied. It appears from the report that as many as 329 classes were held last session in connection with the institute in 116 towns, and that these classes were attended by 7,660 students. In 1879 202 candidates presented themselves for examination from 23 centres in seven subjects, and in 1886 4,764 candidates presented themselves from 192 centres in 48 different subjects. Although the percentage of failures this year has decreased from 45·3 to 44·8, the fact that 2,137 candidates were rejected shows that the examinations are by no means easy and that the certificates are awarded to those only who show a competent knowledge of the subjects. The increase in the number of honours certificates, from 406 in 1885 to 622 in 1886, is a satisfactory feature of the examinations. The statistical tables included in the report give full particulars of the successes of the several candidates in the 49 trade subjects in which examinations are held.

The Electric Light at the Liverpool Exhibition.—Considerable additions have been made to the electric lighting department of the Liverpool Exhibition since its opening. A powerful electric light has been placed in the lighthouse in the grounds, and is supplied with current from a 50 volt compound-wound machine, driven by a 4 H.P. vertical engine. The rooms set apart for the display of the exhibits of the upholsterers and cabinet-makers are lighted by glow lamps, and *Engineering* says that whatever may be the rival merits from an economic point of view of electricity and other means of illumination, there can be no doubt that, when skilfully treated, glow lamps have no equal from an artistic point of view.

Earth Currents.—Last Tuesday evening was celebrated for unusually powerful earth currents. These were first noticed on the long wires, and gave rise to such service messages as, "Getting permanent current from you, please examine apparatus," &c. As the evening wore on, the disturbance became more decided, and finally it became impossible to work many of the wires: notably those running in a north-westerly direction. The strength of these currents was estimated as varying from 5 to 30 m. amps., and on some circuits this was certainly exceeded. Their direction remained constant, but their strength varied continually, though in no case very suddenly. The effects of these alterations in strength on a quiet room full of instruments was, as may be imagined, rather curious.

The Regent Primary Battery.—After our pages were made up ready for press we received the following letter:—

"32, Craven Street, London, W.C.,
"28*th July*, 1886.

The Regent Primary Battery.

"Sir,—We understand that Mr. Sydney F. Walker, of Cardiff, has sent you for publication a report which was made for the proprietors of this invention, and that it is your intention to publish this report.

"We may say at once that the report has been sent to you under a misunderstanding, and that it is the property of our clients, the proprietors of the invention, and it was made for them confidentially.

"Under these circumstances we must request you not to directly or indirectly publish it, or in any way refer to it. "We are, Sir, yours faithfully,

"HALLETT & SPOTTISWOODE.

"To the Editor of the ELECTRICAL REVIEW."

We do not know Messrs. Hallett & Spottiswoode, nor do we know the proprietors of the battery mentioned by them, but we think that both the above firm and its clients might have had more consideration than to have asked us at so late a date to make the extensive alterations in our pages which they desire in their letter. From the nature of the report we do not think that the success of the battery in question can be either made or prevented by our simply criticising that document, and it seems to us that Messrs. Hallett and Spottiswoode and their clients have cause of complaint against Mr. Walker, if against anyone. That gentleman, however, in a letter to us, published on page 72 of the ELECTRICAL REVIEW, gave us his permission to publish his report, and in a letter dated the following day wrote: "Since writing you yesterday, I have received my client's permission to place my report at your disposal; I will, therefore, send you a copy, all being well, on my return to Cardiff at the end of the week." As Mr. Walker had the necessary permission, we forthwith proceeded, and decline at this late hour to do that which would cause us much inconvenience (of delay) and expense.

Incandescent Lamp Monopoly.—Messrs. Shippey Brothers apparently intend to leave no stone unturned to frustrate if possible a monopoly of the incandescent lamp trade. This firm states that a meeting is about to be convened, which the entire trade is invited to attend to fully discuss the position of affairs owing to the actions taken by the above company. At this meeting Mr. Arthur Shippey proposes to point out the weak points of both the Edison and Swan patents, and lay before the meeting a number of reasons why this company is not entitled to a monopoly of the incandescent lamp trade. This meeting will certainly be looked forward to by many with interest, pending the appeal case of Messrs. Woodhouse and Rawson, and it will excite not a little curiosity if Mr. Shippey can bring forth facts which are at present unknown and which may in any way tend to frustrate a threatened monopoly.

The Telegraph in Algeria.—The Franco-Algerian telegraph system is being completed to Biskra, but the communication between Biskra and Tugurth and Dabila oasis, situated at a great distance to the south, is kept up by means of the optical telegraph, the sun being utilised in daytime, and at night electricity. The optical system will be always kept in operation, as it is apprehended that nomads might cut the wires.

NEW COMPANIES REGISTERED.

F. Williams, Limited.—Capital £10,000 in £1 shares. Objects: To carry on business as manufacturing chemists, mechanical, gas, and electrical engineers and metallurgists. Signatories: C. T. D. Crews, 33, Throgmorton Street, 1,250 shares; A. Lichlenstadt, 33, Throgmorton Street, 1,250 shares; G. J. Poston, 10, Throgmorton Avenue, 100 shares; T. H. Bellis, 6, Jeffreys Square, 4,799 shares; C. H. Feiling, 14, Throgmorton Street, 2,500 shares; J. M. Hume, 6, Jeffreys Square, 1 share. Registered 22nd inst. by E. F. Gaisford, 1, Mitre Court, Temple. Registered office, 6, Jeffreys Square, St. Mary Axe.

Chubut Company, Limited.—Capital £105,000 in £100 shares. Objects: To construct public works of all kinds in the Argentine Republic, including railways, tramways, telegraphic, telephonic and electric light and power supply works. Signatories (with 1 share each): Thos. Best, 17, James Street; Arthur Isaacson, 14, Water Street; A. Pilkington Bell, C.E., 14, Cook Street; E. Percy Bates, 3, New Quay; W. Tod, 7, Tithebarn Street; W. Rodger, 17, James Street, all of Liverpool; H. Pethick, Weston-Super-Mare; R. Huxham, 81, Gracechurch Street, E.C. The signatories are to appoint the first directors, qualification 10 shares; the company in general meeting will appoint remuneration. Registered 27th inst. by Messrs. Robins, Cameron & Co., of Gresham House, acting as agents for Messrs. Bateson, Bright and Warr, of Liverpool.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Kensington Court Electric Lighting Company, Limited.—The registered office of this company is at 11, Great George Street, Westminster.

Gas and Light Company of Portugal, Limited (Gas and Electrical Engineers).—The statutory return of this company, made up to 30th ult., was filed on the 2nd inst. The nominal capital is £100,000 in £5 shares. The number of shares taken up is 1,559, and there has been called up upon 1,489 shares the sum of £2 per share, the remaining 70 shares being considered as fully paid. The calls paid amount to £2,894 and unpaid to £84. Registered office, 37, Walbrook.

Universal Telephone Company, Limited.—The secretary of this company has notified the Registrar of Joint Stock Companies that the company was registered under the Companies Acts on the 4th September, 1885, but has never raised any capital nor done any business.

CITY NOTES, REPORTS, MEETINGS, &c.

The Edison and Swan United Electric Light Company, Limited.

THE third annual general meeting of this company was held at the Cannon Street Hotel on Tuesday, the chairman, Mr. James Staats Forbes, presiding. The following report was submitted to the shareholders:—The directors herewith present their report, and the accounts for the year ending 30th June, 1886, and regret that the result of the year's trading has not been more favourable. There has been a considerable diminution in the number of lamps sold in the year. The delay in the trial of the actions against Messrs. Woodhouse and Rawson, notwithstanding the efforts of the company to bring them on, has been most detrimental and

damaging to the company's interests, as it has led to wholesale infringement of the company's patents. Some manufacturers have been selling lamps at an entirely unremunerative rate, and the company has suffered materially from this cause. Since the judgment the sale of lamps has improved, and as the judgment becomes better known, orders may be expected to increase considerably. In their last report, the directors stated that they had purchased a freehold factory at Ponder's End, to which the transfer, from Newcastle, of the manufacturing business has been successfully carried out. The two actions which the company brought against Messrs. Woodhouse and Rawson for infringement have been tried before Mr. Justice Butt, who decided both suits in favour of the company. The directors congratulate the shareholders on this result, which cannot fail to have a favourable influence on the prospects of the company. Messrs. Woodhouse and Rawson have given notice of appeal, but there is every reason to believe that the decision will be upheld. The amount due from Messrs. Woodhouse and Rawson under the judgment cannot yet be estimated, and has not been brought into the accounts. The directors have given notice of the judgment to manufacturers of incandescent lamps and others, who they are advised are infringing the company's patents. Some of these infringers have ceased to manufacture; others are negotiating with the company. The shareholders may rest assured that every effort will be made to uphold their rights, which have suffered so seriously by infringements. The loss on the working of lighting contracts taken over from the old companies, has not yet entirely disappeared. The directors have closed the lighting station at Holborn Viaduct, as they found it impossible, owing to the limited space at their disposal, to make it pay—during the year they have sold the installation at Holborn Restaurant to Mr. Gordon, so that Victoria Station and Messrs. Gatti's are the only rental installations now remaining. The Victoria installation is being re-arranged, and the directors have given notice to Messrs. Gatti terminating the agreement during the autumn. Installation work on payment, which has been very slack during the past year, due doubtless to the general depression, has very recently shown signs of improvement. There is every prospect of a development of train lighting during next winter. No change has been made in the Electric Lighting Act, and central station lighting on any adequate scale is impossible, so long as the present law is in force.

Major S. Flood-Page, the secretary, having read the notice convening the meeting,

The Chairman said he was sorry to see so few of the proprietors present. He did not know whether they might take it as a compliment, and that those who were absent were willing to leave their business in the hands of the directors. But such as the meeting was they were very glad to put before it what they had to say. The report was not so satisfactory as they hoped last year to have been able to present, and yet it was not entirely unsatisfactory from some points of view, upon which he should have to enlarge. They wound up their meeting last year by wishing, on both sides of the table, that the prosperity which then for the first time had seemed to have been achieved for the company, would continue. Well, it had not continued, but, perhaps when they came to details they would see there were some reasons which, although not entirely satisfactory as regards the financial outcrop, still left some ground for satisfaction on other points. The whole story was told in the second paragraph of the report, which stated that there had been a considerable diminution in the number of lamps sold in the year. The diminution was so great that it caused the difference between a considerable profit and the very inconsiderable, in fact quite nominal, profit shown by the accounts. They had sold no less than 125,000 lamps less than in the corresponding period of the previous year. They had tried, of course, to find reasons for that. One principal reason was that in the corresponding year they were the manufacturers for a great foreign trade. That foreign trade was in the hands of another corporation with which they were allied, but which, in respect of that foreign trade, had a separate interest, and in its discretion—whether that might turn out a wise discretion or not they need not discuss now; they would have to discuss it later—it had, following its undoubted right, thought it more in its interest to manufacture lamps abroad than to take them from this company. That accounted for the greater part of the deficiency. About 74,000 lamps which were sold to the Swan Company for their foreign business it had manufactured for itself this year. Of course, that had this effect on the business of this company, that the greater the volume of lamps put out, the less was the relative cost of each lamp. The fixed charges for producing a relatively small number were the same fixed charges for producing a larger number, and the profit realised last year upon those 74,000 lamps would have been as great this year if they had made them, without any appreciable addition to the fixed charges. In the home consumption there had been a decrease of 41,000. He thought that must have arisen from two causes. First of all by reason of infringement. No doubt a great many people made and sold lamps, and infringers, like other sinners, got bolder by impunity. They were not in a position until very recently to call those gentlemen to account. Patents were a property which often required great cost to establish its legal validity. Everybody understood that in this country the law marched very slowly, and the wrong-doer had a great advantage over the righteous one, because it took a long time to get at him. That had been their case. Since they last met they had been successful, notwithstanding a great many evasions of the issue and postponements, in getting a trial, and they had succeeded at that trial upon every point which they contended for in regard to both of what he might call the key patents of the enterprise, the Edison patent and what was called the Cheesbrough patent. These were only two out of a great many others which were really brought up for consideration. If those decisions were upheld it would no doubt be a great benefit secured to the company; in fact, it was securing to the company for what it was worth, the value of those patents as commercial machines, and putting, so to speak, the muzzle on infringers. As he had said before, there were always plenty of people ready to step in between the man who had taken the risk and his profits, and they could only keep those people in order by these patent proceedings. What was going to ensue upon that? The directors were obliged to take the responsibility of expressing opinions, and they said that the result could not fail to have a favourable influence upon the prospects of the company. They knew as a matter of fact that there had been an enormous number of lamps made by Woodhouse and Rawson and a great many others who had found their way into competition with this company, both in price and in the use of the materials. Whether the people who made the competing lamps got a profit upon them or not he could not say; at all events this company lost the profit which it would have derived if it had made and supplied them. The judgment was quite specifically in their favour, but of course Messrs. Woodhouse and Rawson had the right to appeal. Well, the directors only wished they would; they were anxious for them to appeal. They were advised by the same eminent counsel whose predictions in the first instance had been so entirely verified that if an appeal were sought the result would be the same. They had a little inkling of the effect of these judgments from the fact that the orders for lamps since those judgments had materially increased; and they knew also as a matter of fact that Messrs. Woodhouse & Rawson themselves were withdrawing their advertisements and were not pushing their trade, which was rather under a ban, and the pushing of which might entail rather serious consequences. Notwithstanding infringements, notwithstanding the slow progress which had been made in electric light installations, and notwithstanding the competition which had been going on in virtue of those infringements, they had managed during the year to hold their own. They had not gone back; they had not made such a profit as they thought they might have made, but they had not gone back, and in the course of the year they had got rid of what might be called the more dangerous parts of the business, bad contracts in what was called installation rents and so forth, and they had also effected considerable economies in working cost. The result was that, with a largely diminished sale, and with fixed charges which must necessarily be high, plus the cost of manufacture, they had got pretty nearly an even balance. They believed they were treading very safe ground now, and it simply came to this: if they could increase the sale of their lamps from 161,000, which was the number sold in the last twelve months, to 286,000, or any other figure over 161,000, at practically the same cost, it did not want very much arithmetical power to prove that the capital, which was in round numbers £300,000, was not very far from a dividend. There was a fair profit on the lamp; suppose they put it down as low as 1s. 6d., 100,000 at 1s. 6d. —everybody could do that sum; having that in their minds, they could add 50, 75, or another 100,000, and they could see what would be the result. The directors were all satisfied that, humanly speaking, with these patents secured, with the slowly, rather too slowly, but still certainly growing appreciation of the public as to the advantages of the electric light for the purposes they intended to follow out, namely, domestic lighting, lighting of factories, offices, and so forth, there was reasonable prospect at no distant date, perhaps in this year, of a tangible profit to handle. He had to administer this song of the Swan so often that he sometimes doubted whether he was quite sincere about it; but he could assure them now that this thing was in such a position that there was a reasonable future for the company, and his conviction was that in the course of a moderate number of years there might be a very excellent outlook, because he was not at all aware that the prosecution of their business and the manufacture of a very large number of lamps would involve an outlay of any more money, and he was not aware that the fixed charges of conducting the business, such as rents of premises, and other established charges, were likely to be influenced by a very much greater output of lamps than they were producing now. The only additional cost attending the production of double or treble the number of lamps would be that relating to material and wages. With regard to the notice to manufacturers mentioned in paragraph five of the report, they had simply given that notice as their duty. Some of the infringers had caved in, as it was vulgarly called, at once; they saw it was no use attempting to disregard a judgment of the character of theirs. They should call upon all infringers as it was their duty and their right to do under their judgments. He saw Mr. Sellon looking at him, so he would say that they were not going to do that in a manner offensive to the public or injurious to their character as men of business. They had succeeded already in inducing one, and perhaps other great consumers, to adopt the views they had put before them, so that they would be left in undisturbed possession of the lamps, merely recognising the right of this company to have the profits arising from the production of the lamps. That was the spirit in which they would meet all who met them in a reasonable way. If, as some of them seemed disposed to do, they tried to "come the bounce" upon them, he thought they would know how to meet them. As long as people were reasonable, the company would be reasonable. If they were driven to press their rights —and he said in the presence of their legal advisers, Mr. Crisp

and Mr. Winterbottom, that they were not particularly anxious to incur more legal cost than was necessary—they would be prepared to defend their interests against all comers. One branch of their business showed a sad story. He was afraid that every man's own career showed many things which he could wish undone; and combinations of many men were not more wise than individuals. Their combination was one that must wish many things undone. One of the worse things they ever did was to believe, on something like speculative knowledge, that installation work at rentals was going to be very excellent business. They had found that not a single thing their company had been concerned in from first to last had been anything but a tremendous loss, and when it fell to the lot of the present united board to sit down after the amalgamation, which took place, after all, not very long ago, to bottom all this, they were faced by the serious results of mistakes by both companies. They had been working these things down, and last year they had to report that they had got rid of some of them. This year, he was happy to say, they had got rid of others. Other people might have been more happy, but their experience might be taken to illustrate this position, that no installation for the supply of electric light at rental upon the principles laid down for their guidance, and accepted by the board under the advice of the experts, could possibly land the undertaking in anything but ruin. Of course, he was only saying upon their principles. They were told, and it was drummed into them over and over again—he took a good part himself in the proceedings before the Board of Trade—every inventor connected with this business had one fixed idea, and that was that the supply of electricity for lighting could be safely undertaken at about the price of gas. Well, that had turned out to be utterly illusory; and, in their case, the long and the short of the matter was that they had not only lost very heavily upon all those contracts in the mere maintenance, that was to say, they had put in the machinery and sunk their capital, with the result that the mere running of the machines swallowed up all the rent they got, and they were left with the machinery on their hands, high and dry, to get rid of at enormous loss. That was what they had gone through. They had got rid of the installation at the Holborn Restaurant to Mr. Gordon; they came out of it very badly indeed, but they were out of it. Mr. Gatti had rented another installation, but the results had been so bad that they were taking the opportunity of terminating that agreement; they would come out of that at a loss; there was no use crying over it—it was loss. They had only one legacy of that kind remaining on hand, and that was at the Victoria Station, and that had elements about it, he thought, of consolation; although at the present moment it did involve a loss, yet it was installed for the purpose of lighting not only the Victoria Station of a distinguished railway company with which he had some indirect connection, but the scheme embraced the station of the Brighton Company and the Grosvenor Hotel; it had not been extended to those places for the reason that the machinery first put down was insufficient to produce the necessary power; they were now supplementing that machinery by other machinery of their own removed from other places, and they hoped the result of what they were doing now would be to extend the area of supply, which they could do without interfering with the Electric Lighting Act and without getting the consent of the local authority, because it would be all on private ground. They hoped this, if it did not realise a brilliant profit, would at all events remove any serious loss, therefore what they were coming to was very much this: they knew the worst of the lamp business; there was good ground for reasonable hope that that would largely increase and bring them considerable profit; and with respect to installation business, they knew that the heavy loss resulting from that up to the present time was now almost wholly removed. Coming to paragraph seven, the report said that installation work on payment had been very slack during the past year. There was no doubt that was so, because they would remember that, under the inspiration of the Board of Trade, a committee of the House of Lords was appointed to consider the Electric Lighting Act of 1882, and there were still some people so sanguine as to believe that electric lighting for public purposes on a large scale could be carried on under the conditions of that Act. There was a very long enquiry; Lord Camperdown was the chairman, and a great number of distinguished men was on the committee. Anybody who was much interested could read the evidence which was now, or would shortly be published as a blue book. He was sorry to say that the strong opinions expressed by men like Sir Frederick Bramwell, who had a head for this kind of scientific business, combined with more knowledge about its economical application than most scientific men possessed, were disregarded. Those who were most concerned came to the conclusion that it was quite impossible to expect that electric lighting on anything like a large scale, in London at all events, could be undertaken under that Act. The Board of Trade, however, seemed not yet to have recovered from the effect of the strong evidence of the scientific men who were examined when the first committee sat, that under the conditions of that Act all the world would be wanting to rush into electric lighting. They seemed to think that all that was needed was to extend the period of working from 21 to 42 years; they left all the other vital questions exactly where they were. But the Act was not amended, for when the Bill was brought before the House Lord Houghton tried to get in a clause which the committee had declined to accept, and because he did not succeed the Bill was withdrawn. The Electric Lighting Act, therefore, stood now where it did before—an Act to make electric lighting, in London at all events, impossible. While people were believing that they were going to have, under some amended legislation, a kind of public supply in their houses, it was not a very good time for installations. He thought that would account for the period when installation business was practically suspended. He was reminded of something which he did not know whether he ought to confide to an appreciative public through the press; but the fact was, and everybody could see it, that if they made a lamp to last for ever, there could be no renewals of it, and really their lamps, under improved processes, were made to last so long a time that when once an installation was equipped the per centage of renewals was greatly diminished. Whereas it used to take about 25 per cent. in the shape of new lamps in the course of the year it had now got down to something like 12½. There at once they had a factor telling against themselves. Perhaps it was not impossible that when the lamp became so greatly improved in life and efficiency by the application of skill and science, the price might go up, but that was as yet inoperative. He would advert briefly to the accounts. The share capital remained exactly as last year. There were 17,000 A shares paid up, 89,261 A shares £3 paid, and they had not been added to in any shape. According to the agreement with Mr. Edison that gentleman was entitled to have B shares created of £5 each, fully paid up, in the proportion of £5 for every £15 of cash invested in the A shares. Some day or other, when the shareholders holding A shares got 7 per cent. cumulative interest, Mr. Edison would share upon the theory of his being entitled to shares amounting to £117,820. That was not an immediate contingency, for he was sorry to say there was a large preferential dividend now due. He hoped most heartily that Mr. Edison would come in, as he most eminently deserved to do, for some beneficial interest in virtue of his invention and those shares. Then there were sundry credit balances amounting to £13,350. The balance on the profit and loss account for the year was £24 5s. 6d. This was very humiliating, but he had explained the reason, and he could not attribute to anyone the responsibility of the falling off in the sales which might have made that £24, £12,000 or £15,000. On the other side of the accounts was shown the investment of their money. Well, that was an old story, and as he had said before, what was the use of crying over spilt milk? When the money was invested in that way, the people who so invested it were very unwise. That was all. But they were unwise in common with the rest of mankind. Everybody thought it was going to be a gold mine, and very large sums of money were paid for patents which had turned out to be exceedingly doubtful and had involved a large expenditure to establish legally, on the theory that those patents would produce very large results. Up to the present time they had not done so. He did not know whether the consciences of those people who accepted those sums were at all tender, or if they were affected by the present outcrop; if they were, they would immediately proceed to refund the very large sums paid to them for something which had turned out to be almost worthless. The Chairman concluded by moving the adoption of the report.

Mr. Leyland seconded the motion.

Mr. Porter expressed his appreciation of the clear and explicit statement of the Chairman, and enquired whether the foreign sales were likely to increase.

The Chairman replied that they had some knowledge on that point from their connection with the Swan Company. He had no doubt the consumption of lamps in foreign countries was being limited whilst litigation was pending. They did not know what might result from that litigation, but so far the sales had not diminished abroad; in fact they showed a substantial increase. The two things were practically on all fours, with this important difference, that amidst a great many competitors for lamp making in England they were the only ones who had established a patent. He believed there were some other pretenders to the throne; there always were some. Abroad nothing had yet been established; sometimes they had got the best of it, sometimes the worst. They were trying there to patch up a peace between the contending parties. It was a very odd thing that the most severe contention was taking place abroad between the two interests which were happily united at home. Here, in consequence of their being opponents, they made a very bad and costly start, but they had happily got together with a certain prospect, which he thought was not an unfavourable one; abroad they were fighting one another, doing what they wisely avoided here. They had been trying for a long time to induce the foreign Edison Company to take the same sensible view of the matter that the English Edison Company did. But it was not so easy a matter, for the English Edison Company was in the hands of one body, whilst the foreign Edison was in the hands of a great many people. He hoped, however, that in the result the two parties would come together.

Mr. Pryor asked if there was not hanging over them a very large charge for legal expenses?

The Chairman stated that they thought they had better pay as they went along, and a portion of the legal expenses was included in the accounts. They had a discussion as to whether the income of one particular year should be loaded with the cost of establishing a patent. They came to the conclusion, in concurrence with the opinion of the auditor, that the cost of maintaining the validity of the patent was as much a part of the cost of the patent as was the sum paid to the inventor. Consequently they had made provision for as much money as they thought they were likely to pay, so that there was nothing very serious awaiting them. He ought, perhaps, to have said that in paragraph four of

the report, after dealing with the judgment, they said that the amount due from Messrs. Woodhouse and Rawson under the judgment could not yet be estimated, and had not been brought into the accounts. The order was now in form, and they would endeavour to take the account, which, he understood, meant going through the books of Messrs. Woodhouse and Rawson, and tracing what they had done with the infringing lamps. He had reason to believe that they had sold an enormous number, and therefore there was a considerable sum of money to come from those gentlemen.

Mr. Pryor said his desire was to ascertain whether it was likely that the shareholders would be called upon to find any more money.

The Chairman said that, as far as they saw at present, they did not think there was the slightest possibility of any further call being made. They had a considerable balance in hand, and they had debts and other assets, and they had no intention to make a call, nor any belief that a call would be needful within any time that they could foresee. They were under a pledge that they would not make any more calls for the extension of the business, and they certainly should not dream of it without coming first to the proprietors and seeking their entire concurrence in what they were doing. In fact, there was no obligation resting upon the company, and no obligation which the directors were inclined to incur which was not already amply provided for by money or by assets.

A Shareholder asked whether the directors had taken the trouble to form an opinion as to the value of any reliable asset they had at the present time.

The Chairman enumerated the assets, and stated that the B shares were only of value in the event of certain contingencies which were a long way off. But there were the patents, there was a going concern, there was the business. He did not mean to say that that was altogether a gratifying state of things, but it was the state of things they had to deal with, and if the patents were maintained and ran their life, and if at the end of the life of the patent the business of the company was managed with ordinary prudence there would be a going concern with a reputation. With regard to other assets, he believed they were fairly valued. He had no doubt the freehold property represented £32,000, he believed the debts were all good, for a reserve was made for doubtful debts, and he believed they would get £1,100 for the installations in progress.

The resolution was then put and carried unanimously.

The retiring directors, Viscount Anson and Mr. Ernest Villiers, were re-elected, and Messrs. Quilter, Ball & Co. were again appointed auditors.

The meeting thereupon terminated with a vote of thanks to the chairman and other directors.

Direct United States Cable Company, Limited.

THE eighteenth half-yearly general meeting of this company was held at Winchester House, Old Broad Street, on Friday last, under the presidency of Mr. John Pender.

Mr. Fuller, the secretary and traffic manager, having read the notice convening the meeting,

The Chairman stated that the revenue for the half year to June 30th, after deducting out payments, amounted to £28,445, and the working and other expenses, including income tax, but exclusive of cost of repairs, absorbed £15,867, leaving a balance of £12,578 as the net profit of the half year, making, with the £5,967 brought from the previous half year, a total of £18,545, which had been appropriated as follows: interim dividend of 3s. per share to March 31st, £9,106 10s.; proposed final dividend of 2s. per share to June 30th, £6,071; transferred to reserve fund, £316 13s. 2d.; balance carried forward, £3,050 19s. 3d.; total, £18,545 2s. 5d. The revenue showed a reduction of £7,661 as compared with the June half of last year, owing entirely to the introduction of the sixpenny tariff on May 5th. The result of the reduction so far had been to more than double the traffic without developing a remunerative revenue. The working expenses in London and at stations showed a reduction at the rate of £600 per annum, notwithstanding the expenses of advertising and otherwise making known the reduction of rates, and despite the cost of working the new stations at Glasgow, Bristol and Havre. Important economies had been effected from year to year since 1877, so that now they were working down to the lowest point possible consistent with the efficient working and maintenance of the company's system. No further reductions could therefore be reasonably looked for, but every possible economy would continue to be exercised. The reserve fund, after being credited with interest on investments and profit on the sale of a security, and being debited with cost of repairs now amounted to £325,000. The present market value of their investments continued considerably higher than the amount of their cost to the company. These were some of the details connected with the working of the company during the half year. For the last 18 months, when he had met the shareholders at these half yearly meetings, he had told them that there was looming in the distance a competition, and a very active competition it was likely to be, if they really began to fight. His colleagues and himself, and he believed the associated companies were very anxious to prevent that fight. They did everything they could consistent with their duty to their shareholders and with the position they held as the great pioneers of Atlantic telegraphy. The result had been that no arrangement could be come to whereby a rate might be agreed upon that would be fair to the public, and would give the shareholders a moderate dividend. They had never got very excessive dividends, because, what with the competition of cable companies springing up right and left, and what with the coding system at work at the same time, they had never been able to get to that point of dividend to which such an enterprise as Atlantic telegraphy was entitled. Well, if they had not been able to make an arrangement that would give a satisfactory dividend they had endeavoured to do the next best, and that was to utilise their cables to such an extent at low prices as would test the telegraphing public and throw the responsibility of low tariffs upon them. The result was that in reducing the tariff to 6d. they had more than doubled the number of messages passing over the system. In fact he believed the increase was at the rate of 110 if not 118 per cent. That was still insufficient to give the dividend they were entitled to. But, nevertheless, having begun the 6d. rate, and seeing such an enormous development in the short space of time (because they had not been actively competing for more than three months), they thought they might expect to do a great deal more in twelve months, and they had determined to give a fair and proper trial to the existing rate, and they hoped to meet with the approval of the telegraphing public and that the shareholders would be patient, as they had been during the past 18 months, and content to receive the very modest dividend for the next twelve months which would be declared that day. The associated companies had eight cables, which were capable of carrying 40 million words, while they were at present carrying only 15 million words. They thought it better to use that cable power, at all events, for a time, in giving an opportunity to the telegraphing public to double, treble, and, he hoped, quadruple the amount of the present traffic. If that were the case, he thought it would be unnecessary to return to rates much higher than those charged at the present moment. While the associated companies had reduced the rate to 6d., the Commercial Company had only reduced theirs to 1s. They learnt that a very large amount of the support which that company was receiving came from America, but knowing something of the American people and of American mercantile life, he believed that when they found they could get their work done, he would not say better but as well, by the eight cables of the associated companies, the American people were not likely to pay 1s. when they need only pay 6d. He concluded by moving the adoption of the report and the payment of a final dividend of 2s. per share, free of income tax, making a total dividend of 2¾ per cent. for the year ended the 30th ult.

Mr. William Ford seconded the motion.

Mr. Jackson said he had been glad to hear the remarks of the chairman with reference to the question of low rates. In the past the old companies had been held *in terrorem* over the heads of the public, and it had been said of them that when they had succeeded in crushing opposition they would raise the rate to 2s. 6d., 3s., or higher. That had been their fatal policy, but now they would be acting on commercial principles. He trusted that the shareholders would support the board in the present struggle.

Mr. John Newton, Mr. W. Griffith, and other shareholders having spoken,

The Chairman, in reply, stated that the question of paying a dividend had had the serious consideration of the directors, and they had thought it right to give a small dividend to encourage the shareholders, with the directors, to fight the battle. Having a reserve fund of £325,000, they had thought they might suspend for a time making further additions to that fund except what the investments earned. With regard to the question of the proxies, the directors had passed a resolution that they should themselves pay for them. Without proxies, however, it was possible—as was done the other day in Paris—for men antagonistic to their interests to combine and upset them. It was possible that the shareholders might hereafter be asked to pass a resolution authorising the directors to pay the expense of the proxies.

The resolution was then carried.

On the motion for the re-election of the two retiring directors there was some discussion on a proposal for reducing the remuneration of the board from £3,000 to £2,000 a year, or reducing the number of the directors from eight to six, with a proportionate decrease in the remuneration. Other shareholders, however, thought the time inopportune for bringing forward such a proposal.

The Chairman, in reply, stated that the former directors had £4,000 a year, and paid the shareholders not a penny of dividend for the three years in which they acted. When the present board took office—after a fight rescuing the company from wreck—they reduced the fees to £3,000 a year, they had since built up a good reserve fund, and until last year they had paid a dividend of 5 per cent.

The retiring directors, Admiral Mayne, C.B., M.P., and Mr. Charles Meara, were then re-elected, and the auditors, Mr. John G. Griffiths and Mr. John Sawyer, were reappointed.

Submarine Telegraph Company, Limited.

THE report of the Directors states that the accounts for the six months ending 30th June, 1886, show that the joint receipts amounted to £62,643 4s. 1d., and the expenses to £27,303 13s. 3d. The receipts are less than those for the corresponding six months of 1885 by £4,152 12s. 10½d, and the expenses are greater by £3,006 5s. 9d. The net profit is, therefore, reduced by £7,158 18s. 7½d. The result of the half-year's business enables

the Directors to add the usual proportion of the gross receipts to the Reserve Fund; to recommend a dividend at the rate of 12 per cent. per annum; and to carry over a balance of £523 5s. 7d. to the new account. The falling off in the receipts is due in a considerable degree to the reduced length of the messages. The average length of the messages in 1886 was 11·05 words, against 11·72 words in 1885, and the number of messages transmitted in the half-year was 20,777 more, but the number of words was 747,315 less than in 1885. The falling off in the receipts is also partly due to the diminished traffic received from the Indo-European Company and the Eastern Telegraph Company. The increase in the expenses is to be accounted for chiefly by the increase in the salaries of clerks; an additional amount paid to the French Government for the services of their staff; and by the increased cost of the repairs to the Company's cables, amounting to £2,095 12s. 11d. This increased cost arises from the insertion of a new length of about five miles in the Havre Cable to remove some faults in the conductors, and from the repair of four other cables broken on more than one occasion in the half year in the usual manner, viz., by the dragging of ships' anchors.

During the whole of the years 1884 and 1885 there was a remarkable immunity from these accidents. The result was that the drawback paid by the insurance company for the time the repairing vessel was in port extinguished the usual half-yearly charge for insurance in the accounts for the six months ending December, 1885, and left a balance, which has greatly reduced the ordinary charge for the present half year.

The cables belonging to the Government in the North Sea have not been interrupted in the half year. All the company's cables, as well as those worked by the company, are at the present time in good working order.

The Globe Telegraph and Trust Company, Limited.

THE thirteenth ordinary general meeting of this company was held at Winchester House, Old Broad Street, on Thursday, under the presidency of Mr. John Pender. The following report was submitted to the meeting and adopted:—The net revenue of the company for the year, after deduction of expenses, amounts to £167,644 7s. 8d., which, with the balance of £1,791 14s. 10d. brought forward, make a total of £169,436 2s. 6d. From this amount there has been distributed the sum of £117,285 0s. 1d. in interim dividends, leaving an available balance of £52,151 2s. 5d.

The directors recommend payment of a final dividend for the year of 3s. per share on the preference shares, and of 2s. 9d. per share on the ordinary shares (as against 3s. last year), making, with the former distributions, a total dividend for the year of 6 per cent. less income tax upon the preference and 3⅝ per cent. net upon the ordinary shares, carrying forward a balance of £1,564 5s. 8d.

The continued competition between the Atlantic cable companies has led to a further diminution of this company's revenue, and a consequent reduction of the dividends upon the ordinary shares.

The directors have during the past financial year issued 2,000 preference shares, and 2,000 ordinary shares, in exchange for securities of an equivalent nominal value, viz., £40,000 of 6 per cent. debentures of the London Platino-Brazilian Telegraph Company.

Fifty-four of the shares of the German-Norwegian Cable Company have been drawn and paid off at par, and the proceeds carried to the credit of the capital account.

In all other respects the company's investments remain the same as in last year's accounts.

National Telephone Company, Limited.—At a meeting of the directors it was resolved to declare a dividend for the six months ended June 30th last at the rate of 6 per cent. per annum on the First and Second Preference shares, and at the rate of 3½ per cent. on the Ordinary Shares (as against 2½ per cent. for the corresponding period last year), and that of the remaining profits the sum of £2,000 should be added to the reserve fund, and the balance of £947 15s. 3d. carried forward. The unaccrued revenue carried forward to the credit of next account amounts to £43,985 18s. 6d., against £38,641 13s. 10d. carried forward last year.

Eastern Telegraph Company, Limited.—The coupons of the five per cent. debentures, due on August 1st, will be paid after that date by Messrs. Glyn, Mills, Currie & Co. Coupons should be left three clear days for examination.

Brazilian Submarine Telegraph Company, Limited.—The coupons on the five per cent. debentures of this company, due on the 81st inst., will be paid at the Alliance Bank. Coupons must be left three clear days for examination.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 23rd were £2,118, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company Limited. The receipts for the week ending July 23rd were £2,688.

NEW PATENTS—1886.

9478. "Dynamo-electric machines." J. A. FLEMING. Dated July 21.

9514. "Galvanic batteries." E. H. DESOLU. Dated July 22.

9518. "Making carbon electrodes." R. APPLEGARTH. Dated July 22.

9537. "Novel application of the electric light." V. BLUMBERG. Dated July 23.

9575. "Combined electrical motor and fan for forcing air to the flame of oil or other lamps or burners." ROSS LIGHTING (J. H. ROSS) COMPANY. Dated July 24. (*Complete.*)

9582. "Dynamo-electric machines." J. P. HALL. Dated July 24.

9594. "Battery solution." H. WEYMERSCH, J. WHITTALL. Dated July 24.

9606. "Printing telegraphs." A. M. CLARK. (Communicated by S. B. van Nortwick and others.) Dated July 24.

9612. "Electric bells." F. H. ROYCE. Dated July 26.

9674. "Applying electricity to hair brushes and the like." H. P. TRUEFITT. Dated July 27.

9683. "Clutches for electric lamps." C. B. and R. D. NOBLE. Dated July 27. (*Complete.*)

9694. "Making incandescing portion or luminant of incandescence electric lamps." T. MACE. (Communicated by the Vitrite and Luminoid Company.) Dated July 27.

9695. "Materials for use as the incandescing medium or luminant of electric lamps, &c." T. MACE. (Communicated by the Vitrite and Luminoid Company.) Dated July 27.

9696. "Materials for use as the incandescing medium or luminant of electric lamps, &c." T. MACE. (Communicated by the Vitrite and Luminoid Company.) Dated July 27.

9707. "Telephones and telephonic systems." W. C. LOCKWOOD. Dated July 27. (*Complete.*)

9708. "Automatically making and breaking circuit for a dynamo charging accumulators; running two or more compound wound dynamos in parallel circuit." A. B. HOLMES, J. C. VAUDREY. Dated July 27.

9716. "Treating diphtheria by means of galvano-cauterisation." C. A. BUEHL. (Communicated by F. Bloebaum.) Dated July 28.

9739. "Indicators for mechanical telephones." W. C. MUIR, H. A. MAYOR. Dated July 28.

9740. "Electric lighting appliances." J. MUNRO, J. L. BALBI. Dated July 28.

9741. "Electric flash signalling apparatus." E. S. BRUCE. Dated July 28.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

7390. "Improvements in electric arc lamps." O. ROMANZE. Dated June 17. 8d. Claims:—1. In an electric arc lamp, the combination with a single solenoid in the lamp circuit, of a magnetic core for carrying and guiding the upper carbon, and automatic feed mechanism controlled by said core, substantially as described. 2. In an electric arc lamp, the combination with a single solenoid in the lamp circuit, of a tubular soft iron core carrying and guiding the upper carbon, and automatic feed mechanism controlled by said core, substantially as described. 3. In an electric arc lamp, the combination of the upper carbon feeding by gravity, with pendulum and detent mechanism for rendering such feed gradual and intermittent, and a single solenoid in the lamp circuit, said solenoid having a core which operates to lock and to release the pendulum, substantially as described. 4. In an electric arc lamp, having a single solenoid in the lamp circuit, the combination with positive feed mechanism actuated by the weight of the core of the solenoid, of intermittent gravity feed regulating mechanism actuated by the weight of the upper carbon, substantially as described. 5. In an electric arc lamp, the combination with a solenoid in the lamp circuit, of a tubular soft iron core through which the upper carbon passes provided with guide rollers to hold the carbon, and of automatic feed regulating mechanism consisting of a pressing roller mounted in a frame pivoted to the core and pressed against the carbon by springs, and of an escapement and pendulum controlling the revolution of the said roller, and a spring detent for arresting its motion, whereby the feeding of the upper carbon is effected and governed, substantially as described. 6. In an electric arc lamp, the combination with the solenoid, tubular core, guide rollers, rocking frame, escapement mechanism, pendulum and detent combined for operation as described of a pawl engaging with ratchet teeth, on one of the guide rollers not controlled by the escapement mechanism, for the purpose of causing an initial motion to be imparted to the carbon independently of the core, and by the descent of the latter, substantially as described.

9128. "An improved construction of electrical bells and annunciators or indicators for domestic and telegraphic purposes." J. S. SLEDGE and A. SLATTER. Dated July 29. 8d. Claims:—1. Constructing the electro-magnet of a call bell or annunciator with

a core formed in one piece with polar extensions constituting brackets by which the electro-magnet is attached to its support, substantially as described. 2. In the construction of electro-magnets referred to in the preceding claim, arranging the one polar extension of the core as the means of attachment for the armature, which makes contact with a flange-shaped pole formed on each end of the core, and which is connected to the polar extension by a spring, substantially as described. 3. The combination of an electro-magnet having flange-shaped poles formed on its core, with polar extensions constituting bracket for the attachment of the apparatus, the one polar extension having the armature with a striker connected to it by a spring, while the other polar extension carries the bell, substantially as described in the drawings. 4. In combination with an electro-magnet constructed as set forth in the first and second claim, the use of a lever carrying an annunciator disc, and so arranged to gear with the armature of the electro-magnet by means of a catch, that when the armature is not attracted it holds the lever and disc in the raised position, but when it is attracted it releases the lever, and allows it and the disc to fall, substantially as described. 5. The combination with an electro-magnet and armature of a lever with annunciator disc and stud that engages with a hole in the armature, when this is not attracted by the electro-magnet, substantially as described in the drawings.

9217. "Improvements in the construction of boxes or cells for electrical batteries and general purposes." W. H. QUARTERMAN. Dated July 31. 8d. The object of the invention is to construct a box or cell, so that the several parts of which it is composed interlock with each other, by means of joints, which afford continuous support throughout their whole length. All the said parts being thus kept firmly in position, so that not one of them can warp or twist when fitted together. Claim:—The improved construction of a box or cells, in the manner and for the purposes substantially as shown and described.

9388. "Improvements in or applicable to electric tramways or railways." M. VOLK. Dated August 6. 8d. Claims:—1. The use of insulators (such as are used on overhead telegraph lines) for the continuous conductor or conductors of an electric tram line, the said insulators being placed in a box at the side of the central tube or channel and not in the tube or channel itself substantially as and for the purposes described and represented in the drawing. 2. The described construction of channel or tube for containing the conductor or conductors used for electric tramways or railways substantially as hereinbefore described and represented in the drawing. 3. The improved electric tramway or railway described and represented in the drawing.

9436. "Improvements in insulating or coating wires and conductors for telegraphic and other purposes." F. WALTON. Dated August 7. 6d. Claims:—1. Insulating or coating wires or con ductors for telegraphic and other purposes by applying to the same, by the aid of a covering machine and a die or orifice, a composition consisting of oxidised oil, Kaurie, or other gum, castor oil with or without India-rubber, and other materials substantially as described. 2. Insulating or coating wires or conductors for telegraphic and other purposes with compounds substantially as described.

1886.

5611. "Improvements in machinery or apparatus for the generation of electric currents." H. H. LAKE. (Communicated from abroad by The Helios Electric Light and Telegraph Construction Company, of Germany.) Dated April 22. 6d. Claims:—First. A generator of electricity in which the magnetic field consists of electro-magnets which are arranged outside the plane of rotation of the armature, but parallel to the said plane of rotation. Second. The connection of the field magnets with each other by means of electro-magnets, arranged directly between the several pole pieces, or at any other part of the pole pieces.

5745. "Improvements relating to electric conductors or cables, and an insulating compound therefor." H. H. LAKE. (Communicated from abroad by W. P. Tatham, H. B. Tatham, J. Tatham, and D. Brooks, Jun., all of Philadelphia.) Dated April 27. 6d. Claims:—First. In an electric conductor, a woven or braided tape, composed of threads of fibrous material and metallic wire coiled thereon, substantially as, and for the purpose, set forth. Second. A group of insulated wires with flexible tapes formed of fibrous material, and metallic strips or wire interposed between said insulated wires, and having their edges exposed at the surface of the group substantially as described. Third. A cable formed of a bunch of fibrous covered wires with tapes formed of fibrous material and metallic strips or wire, and exterior casing, and an insulating material, for the purpose set forth. Fourth. In an electric conductor, a woven or braided tape composed of threads of fibrous material and metallic wire coiled thereon, the coils having spaces between the same, substantially as, and for the purpose, set forth. Fifth. A cable formed of wires, having between portions of the same tapes or braids composed of threads of fibrous materials, with metal strips wrapped spirally on said threads, the edges of the said metal strips not being in contact, substantially as described. Sixth. A cable formed of wires, the tape surrounding the wires of the central portion of the cable, and tape extending from the first tape to the periphery of the cable, substantially as described. Seventh. In an electric conductor, a woven or braided tape formed of threads of fibrous material having metallic wire coiled thereon, the said braid being placed between the electric wires and having its edges exposed at the surface of the group substantially as, and for the purpose, set forth. Eighth. An insulating compound of resin and resin oil, substantially as described.

6027. "Improvements in and apparatus for recording and reproducing speech and other sounds." J. Y. JOHNSON. (Communicated from abroad by the Volta Graphophone Company, of America.) Dated May 4. 1s. 6d. Relates to an improved form of phonograph, in which a waxed composition is used to receive the impressions. The claims are 113 in number.

CORRESPONDENCE.

Electro-motors.

The letter of Mr. Mordey in your last week's issue is worthy of attention, and I beg to offer a few remarks thereon.

The object which Professors Ayrton and Perry had in view in writing their paper was to discover the conditions requisite for obtaining, from a motor of given weight, maximum output; and since their investigation led them to the conclusion that an armature of large dimensions as compared with the magnets was requisite to this end a method of obtaining constancy of speed other than they proposed was unsuitable for their purpose.

My contention is that just so long as it has been known that the counter electromotive force and therefore speed of a motor with a constant field is expressed by the equation, $e = E - C R$, just so long has it been known that if R could be made practically O the speed would be constant. What was not known so long ago was that machines could be constructed with an armature resistance so low that its effect, as far as regulation was concerned, might be neglected, whether the machine worked as a generator or motor. When in a motor the load is increased, the speed is reduced simply because owing to its resistance a greater electromotive force is required to send the current through the armature; and Professors Ayrton and Perry's system of compounding, applied to their motors when the armature resistance is necessarily high, was devised for compensating the effect of the resistance. Their method is to wind a number of convolutions of series wire on the magnets, the number at a given speed depending on the magnetic susceptibility of the magnet cores, but being proportional to the resistance; and obviously where the resistance is nil the series winding can be dispensed with without affecting the regulation; in other words, where weight is of no consideration, and where in consequence the field magnets can be made heavy and the armature of low resistance, C R, practically vanishes, and e, becomes equal to E.

I do not require to remind Mr. Mordey that motors in which the resistance of the armature is practically nil are machines giving for their total weight an output much smaller than those in which the armature dimensions are considerable, and that consequently the device of making the armature resistance small was inapplicable to Ayrton and Perry's type. But it is going too far to suppose that these gentlemen and others with the above equation staring them in the face were ignorant of the result which might be obtained by making the armature resistance very small, and it is too much to accuse them of ignorance because they did not go to the trouble of proving a self-evident proposition. The fact is that from a motor having a low resistance armature they could not obtain for a given weight such a large output, and for this reason, if for no other, they were obliged to have recourse to other methods of attaining their end.

It is not my intention to criticise Mr. Mordey's article in the *Philosophical Magazine*, although some of his theories would show up but indifferently under the strong light of recent research; but one fact to be emphasised is, that Mr. Mordey has constructed a motor which regulates well, from a knowledge of the

fact that a shunt dynamo regulates at a constant speed. Although mathematicians were aware of the fact that a very low resistance armature would give constant speed while such armatures were not constructed, clearly the fact could not receive verification; but when generators were made with very heavy magnets, and with few turns on the armature, the resistance of the latter scarcely affecting the regulation at constant speed, then was it realised that the same construction could be applied to motors with a similar result; and thus in the words of my former letter was "a fact known long before verified by experiment," the known fact being that the speed would be constant in a motor were the armature resistance sufficiently low.

In conclusion, it might be said that although the fact that a "Victoria" motor had been made to regulate was new to Prof. Thompson when he wrote his book, the knowledge that any shunt motor would so regulate if properly designed may have been comparatively old to him; at least that is the impression of

A Student.

Primary Batteries.

I am uncertain whether your proposed analysis refers to my letters in your columns, or to the copy of my report on the Maquay battery.

If the latter, I must request that you will either publish it entire or not at all. I have not the slightest desire to fill up your columns with voluminous matter that was never intended for them; and, on the other hand, I have not the slightest objection to its being published, only it must be as I wrote it. I am sorry to find myself taking opposite sides in this matter to Mr. Radcliffe Ward. I think, however, that when he has gone deeper into the matter he will be of the same opinion as myself. I would only remark *en passant* that if he has no better argument to bring forward against my views than the illustration of our dear old friend the gas meter, I certainly consider myself master of the field, and I feel sure that every unprejudiced person who understands the subject will be of my opinion.

On this point I beg to enclose for insertion in your columns, if not trespassing too much upon your space, a letter from the manager of our Leeds branch, who has had considerable experience in domestic work. I think his remarks throw a new light upon several points. There is one other point I should wish to mention. Mr. Ward, in a communication the other day, mentioned the subject of E.M.F. at terminals of batteries. It is obvious that measurements of this kind are useless unless all the conditions are stated; as, for instance, what current is passing through the battery at the time; and, further, that some standard is necessary to which all such measurements can be referred. I beg to suggest that the standard be the E.M.F. at the terminals of the battery on open circuit; that is when furnishing no current except the very small one used for measurement. With regard to the Volta-Pavia battery and the 240 hours' run, the Regent can be made to run as long as you please if you make it proportionate.

Sydney F. Walker.

Cardiff, *July 27th*, 1886.

The Upward Battery.

Mr. R. Ward compares the complications of Mr. Upward's system of lighting to those of a gas meter. The analogy is unsound, because in the latter case the whole thing is sealed out of everyone's way, and requires *no* attention except from the company's specially-trained men, whereas the other is of necessity the reverse in all particulars.

The general experience of electrical engineers and chemical students is, if I am not mistaken, that the working of accumulators and the generating of chlorine gas in the present state of the one, and means of performing the other, do and must require a certain amount of careful and skilled attention.

Even if, with Mr. Ward, we exempt those who keep "slaveys" as beneath our consideration in the matter, it is very doubtful whether, say, the gardener, or one of the butler's assistants, at a mansion could safely be trusted to give this care and attention. Then, too, the battery itself, with its tubes, aspirator, and other parts, are very tempting things for the attendant to experiment with, especially if he be of an ingenious turn of mind, or if there was a fault on, such as a partial disconnection or a short circuit.

The day is almost gone by when even "slaveys" will simply obey instructions and perform their duties of charging the chlorine producers with a mysterious powder and liquid, and work in a jackdaw fashion, not knowing the why nor wherefor.

The probability is, I think, that those in charge of the apparatus would aspire to know something of it, as an engine driver does of his engine. But, unlike the locomotive, or even the Westinghouse brake, there is a dangerous element in this which its manipulator is not likely to thoroughly understand and appreciate.

For example, suppose an accidental breakage or even leakage anywhere in the chlorine circuit, or an attempt, which to me seems possible, to over-fill the gas holder, the over-filling of the battery cells, all of which I doubt whether it can be honestly denied are possible contingencies.

Lastly, may it not happen that some officious mechanic coming to the rescue puts water into the chlorine generator, sulphuric acid into the battery, and brine and permanganate of potash into the accumulators. Electricians may be able to follow the reactions that would follow, but the unhappy owner of the plant would certainly vote the electric light a nuisance.

Mr. Upward is undoubtedly to be congratulated on producing a valuable adjunct to the laboratory; but for domestic use such a complicated set of chemical and electrical apparatus ought, I think, to be entirely automatic, well boxed in, and requiring *no* attention, if that be possible, ere it becomes a success.

A. W. Bennett.

37, Park Cross Street, Leeds.

I quite agree with Mr. Walker as to the last few lines of his letter, that it is most desirable, from a purely scientific point of view, to determine exactly what, if any, chemical actions take place within the cell besides the main one. After a time no doubt we shall find leisure to do so with accuracy. All we care to state at present is that analysis shows a trace of H Cl in the effluent liquid, though not so much as we expected to find, seeing that the wash bottle never having been touched, any H Cl given off from the generator must now get to the cells. The quantity, compared with the $Zn\,Cl_2$, is negligible. Mr. Walker's second paragraph last week reads, as a whole, that when a zinc plate is simply placed in a solution of $Zn\,Cl_2$, it forms further $Zn\,Cl_2$; as this cannot be Mr. Walker's meaning, will he kindly explain. As to the rest of the letter, I think I will leave it till Mr. Walker has seen mine of the same date.

As you promise us next week an account of Mr. Dierman's improvement on the de Fonvielle cell, I will not reply to his letter at present, but will content myself with noting that Mr. Dierman reiterates his statement that a lead zinc couple has the same E.M.F. as a carbon zinc one. I will also point out that the use of accumulators, which he seems so surprised to find in Prof. Lodge's report, was stated fully in both your first and second descriptions of the battery.

Mr. Dierman apparently misunderstood Mr. Upward's remark about HO. That gentleman and myself have of course, both of us, seen water written HO in many most interesting and historical old books. Mr. Upward would have made his meaning clearer if he had expressed surprise that Mr. Dierman, with his love of

antique nomenclature, should use such a modern enormity as "chlorine" instead of the hallowed old name of "dephogisticated marine acid gas."

C. W. S. Crawley.

West Kensington, *July 27th*, 1886.

A Simple Alarum.

Perhaps some of your readers who have Waterbury watches, will find that amongst other numerous advantages, it makes a very good alarm for waking one up in the morning. A small groove is cut in the front case, to allow a wire insulated from the case but bare at the end to pass through, this acts as one pole of a bell circuit, and lies close to the face so that the minute hand can pass over it, but the hour hand when coming round to 7 or 8 o'clock or the hour required, will touch it and close the circuit, the watch itself being the other pole. The watch will not be stopped by this, but the bell will go on ringing until the wire is removed, which can be easily done by lifting the case.

Alfred S. Giles.

London, *July 23rd*, 1886.

Work Performed in Telegraphing.

In Mr. Moon's answer to my letter he says: "The constant 1·355 is the number of foot pounds in a watt." This gives 1,010·83 foot pounds as the equivalent of an electrical horse-power per second. Things are looking up for dynamo efficiences. He seems to use numbers for their reciprocals or *vice versâ*. The rectification of another error would render the constant correct.

Ita.

Manchester Technical School,
July 26th, 1886.

Gas Engine Patents.

Our attention has been called to Mr. Clerk's letter in your issue of the 23rd referring to some article on gas engines, which it is our misfortune not to have read. We beg to say that the arrangement arrived at between Messrs. Sterne and ourselves on account of Dr. Otto was the payment of 10 per cent. on engines manufactured by Messrs. Sterne. Whether this can be considered as a victory for Dr. Otto or not we must leave you to decide.

Crossley Brothers, Limited.

Openshaw, Manchester,
July 26th, 1886.

The Critical Speed of Dynamos.

With reference to the question which has been raised in your columns as to the meaning which is, or ought to be attached to the term critical speed, and on which you have invited correspondence, I have certainly regarded the term as applying to that speed at which the series dynamo begins to excite itself; but I quite agree with Professor Silvanus Thompson, that it is meaningless unless the external resistance, or the total resistance is also given, as every series dynamo will have a different critical speed for every change of resistance. Critical current as he suggests would be a sensible expression, as it is necessarily the same for all resistances, and, moreover, it would be useful to know.

I take it that the survival of the term is one of the instances in which the march of the applied science has outstripped its nomenclature.

I believe the term was introduced originally in the very early days of electric lighting, when a dynamo was made to furnish one arc lamp, and when therefore its external resistance was always approximately the same, so far as the critical speed was concerned.

Seeing, however, that the series dynamo is rapidly being supplanted by shunt or compound wound machines, the point can hardly be of much practical importance in the future. With regard to the compound machine, I certainly think the term regulating speed, or as we say more frequently in the workshop, compounding speed is more appropriate than critical speed.

In the first place the regulating speed is not a critical speed in the sense in which physicists understand it, as you may drive the dynamo above or below its proper speed without producing the marked changes we are accustomed to connect with the term critical. The faculty of self-regulation is lost gradually, not suddenly.

And secondly, so far as my experience goes, you would have the same difficulty as with the series dynamo. You can have several regulating speeds, as many as you like within certain limits, in fact in practice varying with the E.M.F. the machine is to deliver. May I suggest that some arrangement should be made to refer these questions, which will be constantly arising from time to time, to some scientific body having authority to decide them, and whose decision should be final.

It is not so very long ago that great confusion existed between the electrical nomenclature adopted by France, Germany, and ourselves, and it is easy to see that with the rapid advance of the science, demanding the introduction of new terms from time to time, we may soon be in the same condition.

Sydney F. Walker.

Cardiff, *July 27th*, 1886.

Generators and Motors.

The general principle, for which I contended in my last letter, that "whatever construction makes a dynamo good as a generator makes it good as a motor" will cover the supposed exceptions in your editorial note. If we require a dynamo of a certain weight, or of a certain shape, we must construct it in the same way whether it is for use as a generator or as a motor.

The Hopkinson-Edison experiment, to which I referred, seems to prove this once for all; and I venture to say that whoever, from a consideration of the reactions in the two cases, has arrived at a different result, has merely got confused over the reactions.

I have not read Mr. Kapp's book, but I gather from your account of it that he says "motors have a theory of their own apart from that of dynamos," which is obviously true. But if, from this difference of theory, he proceeds to infer a difference of practice in construction it is a different matter. I gather that he draws the practical inference that the magnets of a motor may be lighter than those of a generator. This appears to me wholly against the teaching of the experiment I have quoted, which seems to show that if loss resulted from lightening the magnets of a generator it would also result when the same dynamo was used as a motor.

George Hookham.

Birmingham, *27th July*.

JOHN PALMER.—[You are mistaken in your statement that "the current set up in the wire on the one armature will flow in the opposite direction to the current set up in the wire on the other armature." The direction of the induced current which flows through the coils of an electro-magnet when the iron of the latter loses or reverses its magnetism is in the *same* direction as the current which has induced the magnetism; in order that your statement may be correct, this must be the case in one armature, but must be the reverse in the other, which is absurd. The two armatures in the position you have drawn them form practically nothing more than one long electro-magnet divided in the middle; the effect of this division cannot be to reverse the induced current in one half.—EDS. ELEC. REV.]